Ministry of Education and Science of Ukraine

V.N. Karazin Kharkiv National University

Implemented by

order № 1101-1/155 dd. 18.03.2019

President _____ V.S. Bakirov

«____» _____ 20___

Educational-scientific_____program

(educational-professional / educational-scientific)

Pure mathematics (the English language of instruction)

(title of program)

Speciality_____111 Mathematics_____

(code, title of speciality)

Specialization _____

(title of specialization)

the second (Master of Science)___degree of higher education

(the first (Bachelor), the second (Master), the third (Ph.D.)

Approved by the Scientific Council of V.N. Karazin Kharkiv National University

"____19___" _____ November _____ 2018___ , minutes №_4_.

APPROVAL

of educational-scientific program

1.1. Scientific council of the school: minutes №__10___ dd. «___20___»_November_2018.

Head of Scientific council of

School of Mathematics and Computer Sciences _____(G.M. Zholtkevych)

1.2. Methodic committee of the school :

minutes №__5___ dd. «___16___»_____ November _____2018.

Head of Methodic committee of

School of Mathematics and Computer Sciences _____(O.O. Anoshchenko)

1.3. Department: minutes №___4__ dd. «__15____»_____November_2018.

Head of Department of Fundamental Mathematics _____(O.L. Yampolskiy)

INTRODUCTION

Developed by the workgroup consisting of:

Name and surname	Position	Scientific degree, scientific title (by which department given)
Head of the workgroup		
Oleksandr Yampolskiy	Head of Department of Fundamental Mathematics	D.Sc., associate professor, Department of Geometry.
Members of the workgroup		
Svitlana Ignatovych	Professor of Department of Applied Mathematics	D.Sc., associate professor, Department of Differential Equations and Control Theory.
Volodymyr Kadets	Professor of Department of Fundamental Mathematics	D.Sc., associate professor, Department of Function Theory and Functional Analysis.
Tamara Fastovska	Associate Professor of Department of Fundamental Mathematics	Ph.D., associate professor, Department of Higher Mathematics.

1. Profile of the educational program Applied mathematics (the English language of instruction)
speciality 113 Mathematics

1 –General information	
Degree of higher education and qualification	Master of Science, Master in mathematics
Official title of the educational program	Pure mathematics (the English language of instruction)
Type of diploma and the scope of the educational program	Diploma of Master of Science, single, 120 ECTS-credits, apprenticeship 1 year 9 months.
Accreditation availability	
Cycle/level	National Qualification Frame of Ukraine – level 8 , FQ-EHEA – the second cycle, EQF-LLL – level 8
Prerequisites	Diploma of Bachelor of Science
Language of instruction	English
Validity period	20 years
Permanent web address of the educational program	http://math.univer.kharkov.ua/
2 – Aims of the educational program	
Forming and development of general and professional competences in applied mathematics, which contribute to the social stability and mobility of the graduate in the labour-market; gaining of higher professional education, which allows the graduate to perform successfully the functions and the regular tasks of a mathematician in various fields of human activity, national economy and production.	
3 – Characteristics of the educational program	
Subject area (area of knowledge, speciality, specialization (if applicable))	11 Mathematics and statistics, 111 Mathematics

Orientation of the educational program	Educational-scientific, academic. Guarantees the attainment of the complex of general and professional competences, essential for performance of professional tasks in the field of mathematics, specifically, fundamental grounding in mathematics and applied mathematics, fundamental skills in applied research.
Main focus of the educational program and specialization	Special education in the field of mathematics, which embraces fundamental grounding in mathematics, application of mathematical theories in scientific research, technics, information area. Keywords: applied mathematics, scientific research, teaching
Peculiarities	
4 – Work placement availability and further education aptitude	
Work placement availability	Types of economic activity (according to ДК 009:2010): 62.01 Computer programming 62.02 Informational support 72.19 Research and experimental developments in other natural and technical sciences 85.31 Secondary education 85.32 Vocational education 85.41 Vocational education at the higher vocational school level 85.42 Higher education Professional titles of jobs (according to ДК 003:2010): 2121.1 Researcher (mathematics) 2121.2 Mathematician 2132.2 Applied programmer 2310.2 Lecturer 2320 Vocational school teacher; school teacher
Further education	Further education on the third (educational-research) level of higher education.
5 – Instruction and evaluation	
Instruction and training	The main approaches to education are competent, active, student friendly and problem oriented ones. Main methods of instruction are problematic, partially exploring and research ones. Instruction has the forms of lections, including interactive and multimedia lectures, seminars, self-preparation and research work. Design, graphic modeling and interactive communicative technologies of instruction are used.
Evaluation	Four-level and two-level, 100-score grading system by means of the following methods of monitoring with accumulation of scores: *current* (oral and written quiz), *interim* (tests), *final* (written tests, training records), *certification* (Master's thesis defence).
6 – Program competences	
Integral competence (ІК)	ІК-1 – Ability for solving difficult mathematical and practical problems during professional activity or training process, which presupposes doing research and/or introducing innovations and is characterized by complexity and/or indeterminacy of conditions.
General competences (ЗК)	ЗК-1 – Ability for gaining knowledge and skills including areas different from mathematics. ЗК-2 – Ability for using knowledge in mathematics, nature sciences, social and economic areas professional activity. ЗК-3 –Ability for solving professional problems by means of abstract thinking, analysis, synthesis and prediction ЗК-4 – Ability for information retrieval, processing and generalization.

	ЗК-5 – Ability to generate new ideas Information and communication technology user skills. ЗК-6 – Ability for the creation of new projects and their management ЗК-7 – Research skills on the correspondent level. ЗК-8 – Ability for written and oral communication in foreign language (state language as a foreign language for international students). ЗК-9 – Ability for written and oral communication in foreign language ЗК-10 –Communication skills. ЗК-11 – Ability for critical thinking and analysis of professional and social activity of other people and own ones. ЗК-12 – Ability to make decisions taking into account social, ethic, and legal norms ЗК-13 –Ability to take into account cultural differences in professional activity and be tolerant to them
Special (professional, subject) competences (СК)	СК-1 – Knowledge at the level of contemporary achievements, sufficient for research and/or innovation activities in mathematics and its applications. СК-2 – Ability to apply interdisciplinary approaches to the critical comprehension of mathematical problems. СК-3 – Ability to apply principles, methods and organization procedures of research and/or innovation activities. СК-4 – Ability to understand problems and to distinguish their features. СК-5 – Ability to develop a mathematical model of a real world situation and to extend mathematical knowledge into other contexts. СК-6 – Ability to prove knowledge and personal deduction to experts and not experts. СК-7 – Ability to develop projects by means of creative application of present mathematical ideas and creation of new ones. СК-8 – Ability to develop new and improve present mathematical methods of analysis, modelling, prediction, solving problems from new areas of knowledge. СК-9 – Ability to manage the strategy development of a team in the professional process. СК-10 – Self-education and professional development skills on the basis of innovation approaches in mathematics. СК-11 – Didactic knowledge of educational processes and methods in mathematics. СК-12 – Knowledge and ability to research in a specific area of mathematics.
7 – Program results of training	
	ПРН01. To know classification and essence of contemporary global problems and ways to solve them. To have skills in application of this knowledge and methods to investigation of contemporary political, economic, and social processes. ПРН02. To have language skills, sufficient for communication in foreign sociocultural environment with a view to performing communication tasks, to have formed language competence of a foreign student on the elementary level. ПРН03. To have knowledge of main types of partial differential equations, Sobolev spaces theory, methods of investigation of solutions. To have skills in

	application of these methods for investigation of elliptic, parabolic and hyperbolic equations, including equations arising in physical models, skills in construction of approximate solutions. ΠΡΗ04. To have knowledge of basic algebraic objects (groups, rings, fields, modules and vector spaces) and their morphisms; language of categories and functors, tensor products with applications to linear algebra, Euclidean domains, principal ideal domains and unique factorization domains, structure of finitely generated modules over principal ideal domains. To have skills in applying the above notions and theories to problem solving. ΠΡΗ05. To have knowledge of the basic notions of differential topology, analysis on smooth manifolds, Riemannian and metric inner geometry. To have skills in analysis of smooth manifolds, vector and tensor fields, forms, Riemannian metrics, computation of curvatures of Riemannian manifolds. ΠΡΗ06. To be familiar with the concepts and facts known from the basic Functional Analysis course. To have knowledge of: compactness criteria in infinite-dimensional spaces, spectral theory of compact operators in Banach spaces, functions of self-adjoint operators, unitary operators and polar representation; interpolation of operators and Fourier transform in L_p; reflexivity, weak and weak-star compactness. To have skills at application of Functional Analysis methods and results for analysis of properties of operators in Hilbert spaces and Banach spaces. ΠΡΗ07. To have knowledge of Phragmén–Lindelöf principle, Carathéodory's theorem, concepts of order and type of growth of entire function, their connection to the Taylor coefficients, Jensen's formula, the Weierstrass canonical product for entire function, Hadamard theorem. Skills at finding of order and type of growth for a given function, at construction of the canonical product for a given function, at finding the asymptotics of growth of the canonical product. ΠΡΗ08. To have knowledge of basic approaches and methods of solving optimization problems, basic statements and methods for solving controllability, observability, stabilizability problems, methods of constructing admissible and optimal controls, in particular, for nonlinear systems. To have skills in application of these methods for formulation of optimization problems or optimal control problems in modeling of physical processes and for obtaining exact or approximate solutions of such problems. ΠΡΗ09. To have skills in application of knowledge of mathematics and other areas, in exploration of sources (including ones in foreign languages), in classification and analysis of information obtained, giving talks on seminars, to use known information for obtaining new results, in construction of examples, proving theorems, construction and investigation of new mathematical models of real world processes. To be able to draw up, to present and to vindicate the results obtained.

	ПРН10. To have knowledge of the basic notions and methods related to Lie theory, homogeneous and symmetric spaces, and invariant geometric structures on them, fundamental forms, connections, curvatures, basic classes of submanifolds. To have knowledge of basic constructions in Riemannian geometry and applications of Riemannian geometry to related fields, especially to general relativity. To have knowledge of basics in geometry of fiber bundles, such as base, fiber and projection; connection and connection map; horizontal and vertical distributions; horizontal and vertical projections and lifts; sections; curvature of vector bundle connection. To have skills in using these methods for analysis of Lie groups and algebras, homogeneous spaces, and invariant metrics, in calculations on Riemannian manifolds, in calculation of covariant derivative of section; curvature tensor of vector bundle connection; horizontal and vertical projection of a section of vector bundle; curvature of Riemanian metric on fiber bundle. ПРН11. To have knowledge of: block-bases technique in demonstration of pairwise non-isomorphism of spaces ℓ_p, Khinchin's inequality, type and cotype of spaces L_p; examples of non-complemented subspaces; Pełczyński's decomposition method in the proof that ℓ_∞ and $L_\infty[0,1]$ are mutually isomorphic; reflexivity criterion in terms of basis; the construction of quasireflexive James space; James' theory of unconditional bases; Daugavet's theorem and the absence of unconditional bases in $C[0,1]$ and $L_1[0,1]$; general theory of C-convexity and cotype, B-convexity and type. To have knowledge of filters theory and compactness criteria, axiomatics of topological vector spaces and basic examples; metrizability criteria; classical theorems about linear operators and functionals and their applications, duality theory and weak topologies. To have knowledge of basic properties of commutative Banach algebras and commutative C*-algebras, the general theory of bounded operators on Banach spaces and the theory of normal operators on Hilbert spaces. To have skills at application of this material to solving problems. ПРН12. To have knowledge of basic methods of investigation of well-posedness of nonlinear problems for partial differential equations, compactness method. basic notions and methods of semigroup theory, method of monotone operators, fixed point method, basic notions and facts from the dynamical systems theory, absorbing sets, omega-limit sets, global attractors and their properties, theorems on the existence and properties of attractors, quasistability method, fractal dimension of attractors, sufficient conditions of finite dimensionality of attractors, structure of attractors. To have skills in application of these methods for investigation of solutions to partial differential equations. ПРН13. To have knowledge of basics of Nevanlinna theory, the notion of order and growth type of entire (meromorphic) function, the canonical Hadamard representation of meromorphic functions of finite order, characterization of the Laguerre-Pólya class of entire functions and of the Laguerre-Pólya class of type I, Pólya's theorem on the multiplier sequences, Laguerre's theorems on the CZDS-operators, classical theorems concerning the approximation of continuous functions by polynomials (trigonometric polynomials) in the uniform metric, Bernstein polynomials, polynomials of the best approximation, Chebyshev polynomials, Chebyshev systems, theorems of

	Stone-Weierstrass, Jackson, Zygmund, and Kolmogorov. To have skills in checking whether a given function belongs to the Laguerre-Pólya class, whether a given real sequence is a multiplier sequence, at application of the Laguerre theorem on the CZDS-operators for the zero location of some polynomials and entire functions, in finding of the approximation rate of continuous functions by polynomials (trigonometric polynomials) in various metrics, of checking whether a given system of functions is the Chebyshev system, at application of classical theorems to finding approximations of a given function by polynomials.
8 –Program realization resources	
Staffing	Meets the license requirements. All lecturers are members of staff of V.N. Karazin Kharkiv National University and hold D.Sc. or Ph.D. degrees and/or academic titles in the corresponding specialities. Existing staff undergoes retraining once in five years.
Equipment and facilities	Equipment, educational hardware (multimedia whiteboards, multimedia projectors, laptops, printers, scanners, personal computers with software) for formation of subject competences in educational process. Lecture-rooms, laboratories, computer rooms, student residential complex, canteens, Wi-fi spots, gyms are available.
Dataware	Official site of V.N. Karazin Kharkiv National University, unlimited Internet access, printed (Central Scientific Library of V.N. Karazin Kharkiv National University resources, repository, libraries of laboratories) and Internet resources (including Internet Education Center of V.N. Karazin Kharkiv National University); educational and working plans of courses and trainings (with explanatory notes), educational programs, sets of teaching resources, including lectures, practical tasks, tasks for self-preparation, tasks for current and final monitoring. Meets the license requirements, 100%.
9 – Academic mobility	
National credit mobility	
International credit mobility	There exists a contract of InterMath consortium with University of LAquila.
Instruction of international students	Foreign citizens are accepted on the basis of international contracts, on terms stated in these contracts, contracts between V.N. Karazin Kharkiv National University and foreign universities and organizations and individual contracts.

2. List of the components of the educational-research program and their logical order

2.1. List of the components of the educational-research program

Code of the course	Components of the educational program (courses, research projects (works), trainings, thesis)	Amount of credits	Grading
Compulsory components of the educational program			
OK01	Global problems of contemporaneity	3	Two-level evaluation scale
OK02	Ukrainian as a foreign language	6	Four-level evaluation scale
OK03	Partial differential equations I	6	Four-level evaluation scale

Code of the course	Components of the educational program (courses, research projects (works), trainings, thesis)	Amount of credits	Grading
OK04	Algebra II	6	Four-level evaluation scale
OK05	Differential geometry of manifolds	6	Four-level evaluation scale
OK06	Functional analysis II	6	Four-level evaluation scale
OK07	Complex analysis II	6	Four-level evaluation scale
OK08	Optimization and control theory	6	Four-level evaluation scale
Scientific part			
OK09	Master's seminar	12	Two-level evaluation scale
OK10	Term scientific research work	12	Two-level evaluation scale
OK11	Thesis scientific research training	8	Two-level evaluation scale
OK12	Thesis preparation	8	Four-level evaluation scale
Total compulsory components		**85**	
Elective components of the educational program			
BK01.1	Riemannian geometry	6×2	Four-level evaluation scale
BK01.2	Banach spaces theory		
BK01.3	Partial differential equations II		
BK02.1	Growth and zero distribution of entire functions	5×3	Four-level evaluation scale
BK02.2	Lie groups and homogeneous spaces		
BK02.3	Topological vector spaces		
BK02.4	Dynamical systems		
BK03.1	Constructive function theory	4×2	Four-level evaluation scale
BK03.2	Geometry of fiber bundles		
BK03.3	Spectral theory of operators		
Total elective components		**35**	
TOTAL		**120**	

2.2. Structural logical scheme of the educational program

Term	Components of the educational program	Amount of credits

1	Ukrainian as a foreign language	2
	Partial differential equations I	6
	Algebra II	6
	Differential geometry of manifolds	6
	Functional analysis II	6
	Term scientific research work	4
	Total in the 1st term	30
2	Ukrainian as a foreign language	2
	Complex analysis II	6
	Optimization and control theory	6
	Term scientific research work	4
	Elective course (BK01.1/ BK01.2/ BK01.3)	6
	Elective course (BK01.1/ BK01.2/ BK01.3)	6
	Total in the 2nd term	30
3	Ukrainian as a foreign language	2
	Global problems of contemporaneity	3
	Master's seminar	6
	Term scientific research work	4
	Elective course (BK02.1/ BK02.2/ BK02.3/ BK02.4)	5
	Elective course (BK02.1/ BK02.2/ BK02.3/ BK02.4)	5
	Elective course (BK02.1/ BK02.2/ BK02.3/ BK02.4)	5
	Total in the 3d term	30
4	Master's seminar	6
	Thesis scientific research training	8
	Thesis preparation	8
	Elective course (BK03.1/ BK03.2/ BK03.3)	4
	Elective course (BK03.1/ BK03.2/ BK03.3)	4
	Total in the 4th term	30

3. Form of certification of master's candidates

Certification of master's candidates in the speciality has the form of defence of master's thesis, which is a result of the scientific research work of a candidate. Certification is carried out by the Examining board, approve by an order of the President of V.N. Karazin Kharkiv National University. The Examining board makes a decision on awarding the master's degree in mathematics according to educational-scientific program to a candidate and issues a state diploma.

Only students who performed successfully all requirements of educational plan are admitted to the certification.

Master's thesis is a completed consistent scientific research, which is an evidence of preparedness of a candidate to performing professional tasks using gained integral knowledge and skills. Analysis and applied investigation of mathematical problems are expected. Size and structure of master's thesis is determined by the university. Theses undergo plagiarism checking, according to the procedure, determined by the education quality ensuring system. For the sake of persuasiveness and support of conclusions and suggestions, the talk of a candidate can have a form of a presentation with the use of multimedia equipment.

Certification is held publicly.

4. Matrix of correspondence of program competences to the components of the educational program

	ОК01	ОК02	ОК03	ОК04	ОК05	ОК06	ОК07	ОК08	ОК09	ОК10	ОК11	ОК12	ВК01.1	ВК01.2	ВК01.3	ВК02.1	ВК02.2	ВК02.3	ВК02.4	ВК03.1	ВК03.2	ВК03.3
ІК-1			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-2	+	+	+	+	+	+	+	+	+	+	+	+										
ЗК-3			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-4	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-6									+	+	+	+										
ЗК-7									+	+	+	+										
ЗК-8		+																				
ЗК-9	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЗК-11	+																					
ЗК-12	+																					
ЗК-13	+																					
СК-1			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
СК-2			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
СК-3									+	+	+	+										
СК-4	+								+													
СК-5			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
СК-6									+	+	+	+										
СК-7									+	+	+	+										
СК-8			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
СК-9									+													
СК-10			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
СК-11									+													
СК-12			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

5. Matrix of maintenance of program results of training (ПРН) by correspondent components of educational program

	ОК01	ОК02	ОК03	ОК04	ОК05	ОК06	ОК07	ОК08	ОК09	ОК10	ОК11	ОК12	ВК01.1	ВК01.2	ВК01.3	ВК02.1	ВК02.2	ВК02.3	ВК02.4	ВК03.1	ВК03.2	ВК03.3
ПРН01	+																					
ПРН02		+																				
ПРН03			+																			
ПРН04				+																		
ПРН05					+																	
ПРН06						+																
ПРН07							+															
ПРН08								+														
ПРН09									+	+	+	+										
ПРН10													+				+				+	
ПРН11														+				+				+
ПРН12															+				+			
ПРН13																+				+		