Ministry of Education and Science of Ukraine

V. N. Karazin Kharkiv National University

EDUCATIONAL AND SCIENTIFIC PROGRAM

(educational-professional / educational-scientific)

Computational Physics

(program name)

second (master's) higher education level

(first (bachelor's), second (master's), third (educational and scientific)

Area of expertise 10 Natural Sciences

(code, area name)

Specialization 105 Applied Physic and Nanomaterials

(code, specialty name)

Approved
By the Academic Council
Kharkiv National University
V. N. Karazin ___.__.2024,
Protocol No. _____

Effective from 01.06. 2024.
by Order No. ____-_/____ of __.__.____
Vice-Rector for Scientific and Pedagogical Work
_____ Oleksandr HOLOVKO

Kharkiv 2024

APPROVAL LETTER
educational and scientific program "Computational Physics"

Educational program reviewed and approved:

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

protocol No. _____ of _____.04. 2024.

Chairman of the Scientific and Methodological Council,
vice-rector with scientific and pedagogical work

_____ Oleksandr HOLOVKO

2. To the Academic Council of the Educational and Research Institute for Computational Physics and Energetics:

Protocol No. 2/24 of 27.02.2024.

Chairperson of the Academic Council
Educational and Research Institute
for Computational Physics and Energetics

_____ Iryna HARIACHEVSKA

3. Scientific and Methodological Commission of the Educational and Research Institute for Computational Physics and Energetics:

Protocol No. 2/24 of 27.02.2024.

Chairman of the Scientific and Methodological Commission
of the Educational and Research Institute for
Computational Physics and Energetics

_____ Denys PROTEKTOR

4. Department of Theoretical and Computational Physics:

Protocol No. ___ of __.02.2024.

Head of the Department,

_____ Kostiantyn NIEMCHENKO

5. Guarantor of the educational program

_____ Kostiantyn NIEMCHENKO

PREAMBLE

Developed by a working group consisting of:

Last name, first name, patronymic	Name of the position (for part-timers-place of main work, position)	Scientific degree, academic title, according to which the department (specialty) was awarded
Head of the working group, guarantor of the educational program		
NIEMCHENKO Kostiantyn Eduardovich (guarantor of the educational program)	Head of the Department of Computational Physics	Doctor of Physical and Mathematical Sciences, Professor of the Department of Molecular Physics and Thermal Physics
Members of the working group		
KOKODIY Mykola Grygorovych	Professor of the Department of Information Technologies in Physical Systems	Doctor of Technical Sciences, Professor of the Department of Physics
KULIK Oleksandr Petrovych	Head of the Department of Nontraditional and Energy-technologies and Ecology	Candidate of Physical and Mathematical Sciences, Associate Professor of the Department of Physics od the specialty 104 – Physics and Astronomy
OVCHARENKO Anton Igorovych	Associate Professor of the Department of Computational Physics	Philosophy Doctor (Physics and Astronomy)
ROGOVA Svitlana Yuriyivna	Associate Professor of the Department of Computational Physics	Candidate of Physical and Mathematical Sciences

The following people are included in the design of the educational program:

Employer representatives:		
SOKOLOV Svyatoslav Serheevich	Head of the department, ILT NASU	Doctor of Physical and Mathematical Sciences, Professor
MORGUN Oleg Mykolaevich	Director of Radioprom LTD	Candidate of Physical and Mathematical Sciences,
Representatives of students		
MELUTA Vladyslav Vasilyovych	The 3d year student of ERI SPE	The Head of Students' Professional Union of ERI SPE
GORDEYEVA Alyona Sergiivna	The 3d year student of ERI SPE	The Head of Student Council of ERI SPE
HERASHENKO Nadiia Oleksiivna	The 3d year post-graduate student of ERI SPE	
MEDINTSEVA Tetiana Volodymirivna	The 2nd year post-graduate student of ERI SPE	

When developing the Program project, the following requirements are taken into account::

1) Branch standard of higher education specialty 105 Applied physics and nanomaterials at the second (master) level of higher education.

2) Recommendations of the leading employer in the field of applied physics, ILT of the National Academy of Sciences of Ukraine.

3) Recommendations of the leading employer in the field of applied physics, the domestic manufacturer of medical equipment "Radioprom" LTD.

1. Profile of the educational program

1-General information	
Full name of the institution of higher education and its structural division	V. N. Karazin Kharkiv National University Educational and Research Institute for Computational Physics and Energetics
Official name of the program	Computational Physics
Higher education degree	second (master's) level
Qualifications to be awarded	Master of Applied Physics and Nanomaterials
Type of diploma and scope of the educational program	Master's degree, 120 ECTS credits, duration of study 1 year 9 months
Availability of accreditation	Accreditation Commission. Ukraine. Validity period-01.07.2025.
Background	Availability of first-level (bachelor's) higher education
Language of instruction	Ukrainian, English
Duration of the educational program	2024 – 2026
Internet address of permanent placement of the educational program description	http://physics-energy.karazin.ua/navch/standarti-vischoi-osviti/osvitno-profesiyni-ta-osvitno-naukovi-programi
2 - Purpose of the educational program	
Program goal	Training of specialists for in-depth research of physical objects and systems, physical processes and phenomena, technological processes based on the creation of applied software products using modern computational algorithm including methods of Machine learning and Artificial Intelligence
3-Characteristics of the educational program	
Subject area (field of knowledge, specialty, specialization (if available)**)**	Area of expertise 10 Natural Sciences Specialization 105 Applied Physics and Nanomaterials
Orientation of the educational program	Computational physics is a complex of sections and directions of physics, other natural and scientific and technical disciplines, which aim to solve physical problems of various origins Professional accents – specialist in computational physics
Main focus of the educational program and specialization	Special education in the subject area, which includes concepts and principles of applied physics, computer and mathematical modeling, intelligent data processing, as such, which ensures the acquisition of relevant competences of the graduate.

	Keywords: physicist - researcher, mathematical models, data processing
Programm Features	Training of specialists who possess the following integral competence: the ability to independently set and solve research problems in the field of applied physics and nanomaterials using information technologies at an innovative level.
4 - Suitability of graduates for employment and further education	
Suitability for employment	The specialist is able to perform the specified professional work according to DK 003:2010 and can hold primary positions: 2111.1. Research staff (physics, astronomy) 2310.2 – Teacher of a higher educational institution This list is not exhaustive.
Further training	The possibility of studying for a third cycle program in this field of knowledge (which is consistent with the master's degree obtained).
5 – Teaching and evaluation	
Teaching and learning	General lectures, lectures-seminars of a problematic nature, practical classes, laboratory classes, individual work and work in small groups, seminars-discussions, independent work with literary sources, the ability to generalize
Rating process	Four-level and two-level, 100-point assessment system through such types of control with the accumulation of points received: current control, intermediate (protection of practical, independent works), *final report* (written exams, test papers, defense of practice reports), self-monitoring, *certification process* (preparation and public defense of the master's thesis).
6 – Program competencies	
Integral competence	The ability to independently set and solve research and technical tasks of applied physics and nanomaterials with the use of information technologies at an innovative level.
General competences	GC01. Knowledge and understanding of the subject area and understanding of professional activity. GC02. Ability to communicate in the national language both orally and in writing. GC03. Ability to communicate in a foreign language. GC04. Skills in using information and communication technologies. GC05. Ability to learn and master modern knowledge. GC06. Ability to search, process and analyze information from various sources. GC07. Ability to work in a team. GC08. Interpersonal communication skills. GC09. Ability to work autonomously. GC10. Skills of performing safe activities. GC11. Ability to abstract thinking, analysis and synthesis

	GC 12. Ability to generate new ideas (creativity). GC 13. Ability to conduct research at the appropriate level. GC 14. The ability to use theoretical and practical knowledge of a wide range of computational methods and mathematical algorithms, including the principles of development and generalization of these methods and algorithms GC15. Ability to apply computational methods to obtain information from experimental data and solve scientific problems GC16. Understanding the limitations of numerical methods, including approximation errors, rounding errors, and limitations on the application of specific algorithms GC17. The ability to transform scientific problems into general computational models and understand how various sources of error affect the accuracy and reliability of models and calculated results GC18. Knowledge of a large number of advanced algorithms for solving a wide range of problems and ways to use them in available software
Special competencies	SC01. The ability to perform an analysis of special literature, to formulate a statement of a scientific or scientific and technical problem, to choose methods and techniques, to draw up programs of scientific research and scientific and technical developments in the field of applied physics and nanomaterials. SC02. The ability to optimally determine the material resources necessary for carrying out scientific research or scientific and technical development (materials, apparatus, equipment, computer equipment, etc.). SC03. The ability to analyze the obtained results, present them to specialists in the field, draw up scientific articles and scientific and technical reports, including from related fields, to solve production problems. SC04. The ability, in accordance with the given task, to independently and in a team conduct scientific research of physical systems, phenomena and processes (experimental, theoretical, computer modeling) in the field of applied physics and nanomaterials. SC05. The ability to ensure the implementation of the results of scientific research through the creation of new materials, devices, technologies and others. SC06. Practical computing skills, including interactions between scientific problems and data, mathematical models, general algorithms, and reusable software SC07. The ability to analyze and visually display the results of calculations and evaluate their relevance in relation to the main problems and / or hypotheses SC08. Strong understanding of high-performance computing elements, including memory usage, vectorization, and parallel algorithms, as well as relevant software tools such as debuggers, test frameworks, scripting, and version control systems SC09. Ability to program in high-level languages, compile languages and effectively use a computer algebra system SC10. The ability to improve the efficiency of numerical algorithms and corresponding software SC11. Acquaintance with methods of joint software development

7 - Program learning outcomes	
Program learning outcomes	PLO01. Use knowledge in the field of applied physics, mathematics, electronics, and information technologies to perform scientific research and solve production problems. PLO02. Find and analyze scientific and scientific and technical information in the field of applied physics and nanomaterials from domestic and foreign sources, including using modern search engines. PLO03. Discuss and find progressive and innovative solutions to problems and tasks in the implementation of scientific and technical and production projects. PLO04. Establish and argue for new dependencies between parameters and characteristics of physical systems. 5 PLO0. Work effectively both individually and as part of a team, evaluate and ensure the quality of work performed in the field of applied physics and nanomaterials. PLO06. Formulate professional conclusions in the correct form, test them and convey them to audiences of various professional levels, using modern methods of scientific and technical communication in Ukrainian and foreign languages. PLO07. Fundamentally understand and know the principles of scientific work and the scientific method, including ethical and social constraints and opportunities. PLO08. Be able to develop hypotheses and propose ways to test them using appropriate analytical, experimental and numerical tools PLO09. Professionally communicate scientific problems, results and uncertainties, orally and in writing PLO10. Have a developed sound scientific intuition and be able to reflect and develop effective and personal learning strategies PLO11. Be able to work independently but also in close collaboration with others to complete a research project on time PLO12. Critically understand scientific methods, have a better understanding of the scientific process as such, and also understand the prospects of future work.
	8 - Resource support for program implementation
Specific characteristics of human resources support	Complies with the license conditions for educational activities. All teachers are full-time university teachers, have a scientific degree and / or academic title corresponding to the main profile of the discipline taught. All teachers undergo advanced training once every five years.
Specific characteristics of logistics support	Computing equipment and equipment, data processing and image processing laboratory, modern computer equipment, multimedia complexes, special equipment
Specific characteristics of information and educational support	Official website of the University, unlimited access to the Internet, printed materials (collections of the V. N. Karazin Central National Library, repository, own libraries of educational laboratories) and Internet sources (incl. e-learning Center of the University) information; training and work plans (with explanatory notes to them), educational programs, working programs of disciplines and practices, educational and methodological complexes of disciplines, including lecture material, practical work tasks,

	questions of seminars, tasks of independent work, questions, tasks, tasks for the current and final stage of the project. control system. Meets the license conditions, 100%
9-Academic mobility	
National credit mobility	On the basis of bilateral agreements between Kharkiv National University named after V. N. Karazin and other universities of Ukraine
International credit mobility	Within the framework of international research and educational programs, in particular, the EU Erasmus+ and Horizon 2020 programs, on the basis of bilateral agreements between V.N. Karazin Kharkiv National University and educational institutions of partner countries
Training of foreign applicants for higher education	Citizens of other countries are accepted for training on the basis of international agreements on the conditions defined by these agreements, as well as agreements concluded by an educational institution with foreign educational institutions, organizations, or individual agreements or contracts.

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

2.1. List of ESP components

The educational component of the educational and scientific program (ESP) of the Master of Applied Physics training provides for the following training cycles:
– a cycle of general training;
– professional training cycle, including practical training;
– elective disciplines.

Code of the Discipline	Components of the educational program (academic disciplines, course projects (works), internships, qualification work)	Quantity credits	Final control form
1	2	3	4
1. Mandatory ESP components			
1.1. The Cycle of disciplines that form general scientific competencies and universal skills of the researcher			
MC01	Current global issues	3	test
MC02	Advanced Math for Physics	6	exam
MC03	Selected Topics in Mathematical Physics	6	exam
MC04	Nanophysics and nanomaterials	5	exam
		20	
1.2. The Cycle of disciplines that form professional specific competencies			
MC05	Introduction to Random Processes	6	exam
MC06	Stochastic Processes in Physics	4	test
MC07	Physical Kinetics	6	test
MC08	Approximate Methods for Math Physics Problem Solving	4	exam
MC09	Methods of finite and boundary elements	5	exam
MC10	Introduction to Machine Learning	4	test
MC11	Computational experiment in physics	5	test
MC12	Research practice	15	test

MC13	Pre- diploma practice	9	test
MC14	Preparation of the qualification work	6	
		64	
Total of the cycle		**84**	
2. Elective ESP components			
	Every of 7 disciplines is selected according to the catalog of selective disciplines of the department with a total volume of 40 ECTS		
SC1	Discipline 1	4	test
SC2	Discipline 2	4	test
SC3	Discipline 3	4	test
SC4	Discipline 4	10	exam
SC5	Discipline 5	5	test
SC6	Discipline 6	5	test
SC7	Discipline 7	4	exam
Total of the cycle		**36**	
TOTAL SCOPE OF THE EDUCATIONAL PROGRAM		**120**	

2.2 The research component of the educational and scientific program

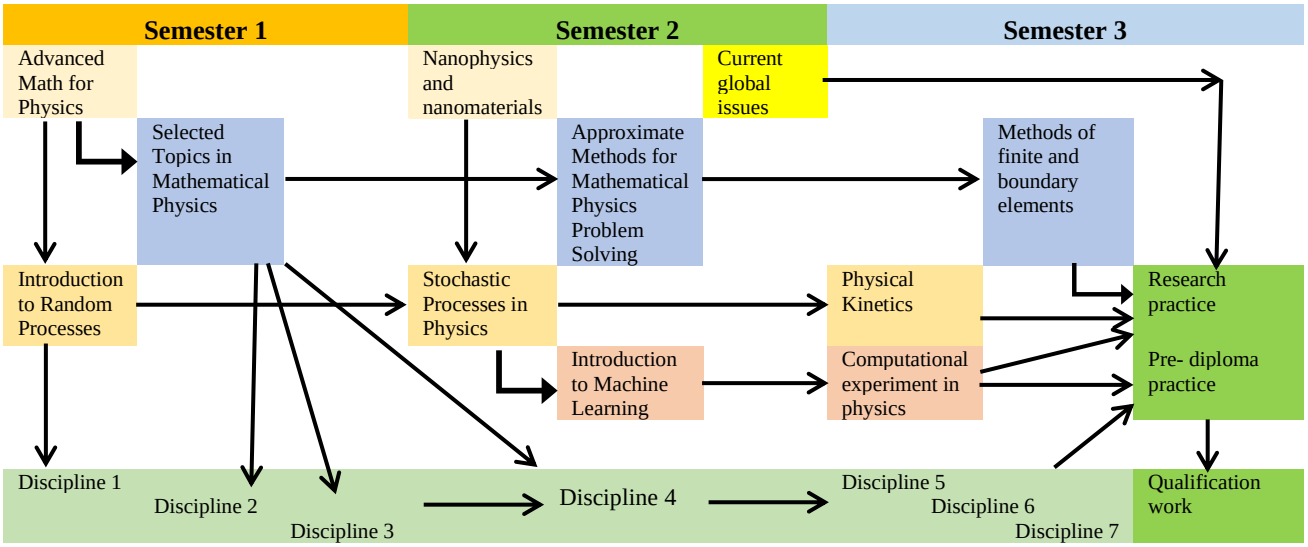
The research component of the educational and scientific program provides for:
– Approval of the research topic and master's supervisor;
- Conducting one's own scientific research under the guidance of one or two supervisors
- Publication of research results in the form of research articles, reports and presentations;
- Preparation of research results in the form of a master's thesis.

Reports on the performance of tasks of the research component:
– Presentation of the results of scientific activity during the third semester in the form of a scientific article during a presentation at the seminar of the department as part of the credit for the educational discipline MC11 "Computational experiment in physics".
– Presentation of the results of research activities during research practice in the form of a report at the seminar of the department as part of credit for research practice;
– Presentation of the results of preparatory activities during pre-diploma practice in the form of a report at the seminar of the department as part of credit for pre-diploma practice.

Credits distribution in the research component

Code of the Discipline	Components of the educational program	Total credits number	Research component credit number
MC06	Stochastic Processes in Physics	4	3
MC09	Methods of finite and boundary elements	5	4
MC11	Computational experiment in physics	5	4
MC12	Research practice	15	15
MC13	Pre- diploma practice	9	8
MC14	Preparation of the qualification work	6	6
			40

3. Structural and logical scheme of the ESP



4. Form of certification of applicants for higher education

Certification of higher education applicants is carried out in the form of a public defense of a qualification (diploma) thesis.

The master's qualification (diploma) work is a completed development that reflects the integral competence of its author. The qualification paper must present the results of experimental and/or theoretical research conducted using the provisions and methods of physics and astronomy, aimed at solving a specific innovative scientific task characterized by complexity and uncertainty of conditions.

The master's thesis is subject to mandatory verification for academic plagiarism. Checking for academic plagiarism is carried out on the basis of regulations developed by universities. To check for academic plagiarism, the text of the final bachelor's thesis is submitted by the applicant in electronic form.

Public defense (demonstration) of a qualifying work provides for:

– presentation of the main points of the work in the form of a multimedia presentation and an explanatory note;

– preliminary announcement on the official website of the higher education institution;

– open form of the commission meeting;

– announcement on the same day after the end of the defense evaluation of the qualification work and registration of the minutes of the commission meeting;

– decision-making by the commission on awarding the qualification.

Public defense is carried out openly and publicly before the examination committee, which is approved by the order of the Rector of V. N. Karazin Kharkiv National University. The applicant's report must be accompanied by a presentation using multimedia technology in order to be convincing and confirm the conclusions and suggestions.

5. Compliance matrix of program competencies components of the educational program

	MC01	MC02	MC03	MC04	MC05	MC06	MC07	MC08	MC09	MC10	MC11	MC12	MC13	MC14	SC1	SC2	SC3	SC4	SC5	SC6	SC7
GC01	*																				
GC02	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC03	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC04		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC05	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
GC06	*	*	*	*	*	*						*	*								
GC07	*			*								*	*								
GC08	*			*								*	*								
GC09	*	*	*		*	*	*					*	*								
GC10	*											*	*								
GC11		*	*		*	*	*		*			*	*		*				*		
GC12		*	*	*	*	*			*							*		*		*	
GC13			*									*	*	*			*				*
GC14								*		*	*				*	*	*	*	*	*	*
GC15								*		*	*				*	*	*	*	*	*	*
GC16								*		*	*				*	*	*	*	*	*	*
GC17						*				*	*				*	*	*	*	*	*	*
GC18								*		*	*				*	*	*	*	*	*	*
SC01				*								*	*	*							
SC02	*			*								*				*		*		*	
SC03												*	*	*			*		*		*
SC04		*	*	*	*		*		*		*				*	*	*	*	*	*	*
SC05				*																	
SC06										*	*	*	*		*	*	*	*	*	*	*
SC07										*	*	*	*		*	*	*	*	*	*	*
SC08										*	*					*		*		*	
SC09										*	*				*		*		*		*
SC10										*	*				*	*		*		*	
SC11											*	*							*	*	*

6. Matrix for ensuring Program Learning Outcomes (PLO) relevant components of the educational program

	MC01	MC02	MC03	MC04	MC05	MC06	MC07	MC08	MC09	MC10	MC11	MC12	MC13	MC14	SC1	SC2	SC3	SC4	SC5	SC6	SC7
PLO01				*					*	*	*	*	*		*	*	*	*	*	*	*
PLO02	*			*								*	*	*		*			*		*
PLO03	*			*		*			*			*	*	*			*	*		*	
PLO04		*		*	*							*	*					*			*
PLO05	*			*						*		*	*			*			*		
PLO06	*											*	*	*					*		
PLO07	*											*	*	*							
PLO08		*																			
PLO09										*	*	*	*	*		*		*		*	*
PLO10												*	*	*							
PLO11												*	*								
PLO12	*											*	*	*							