Institute of Automation and Information Technologies
Department of Higher Mathematics and Modeling

EDUCATIONAL PROGRAM
8D06105 - Digital modeling
code and name of the educational program

Code and classification of the field of education: 8D06
Code and classification of training directions: 8D061 ICT
Group of educational programs: D094 Information technology
Level based on NQF: 8D
Level based on IQF: 8
Study period: 3 years
Amount of credits: 180

Almaty 2024

Educational program 8D06105 – «Digital modeling» approved at the meeting of the Academic Council of KazNRTU named after K.I. Satpayev.
Protocol No.12 of "22" April 2024 year.

Considered and recommended for approval at the meeting of the Educational-Methodical Council of KazNRTU named after K.I. Satpayev.
Protocol No. 6 of "19" April 2024 year.

Educational program 8D06105 – «Digital modeling» developed by the academic committee for the direction 7M061 "Information and communication technologies".

Name and surname	Degree/ academic title	Position	Place of work	Sign
Chairman of the Academic Committee:				
Tulesheva Gulnara Alipovna	Candidate of Physical and Mathematical Sciences, associate professor	Head of Department	KazNRTU named after K.I. Satpayev	
Academic Committee members:				
Sakabekov Auzhan Sakabekovich	Doctor of Physical and Mathematical Sciences, professor	Professor	KazNRTU named after K.I. Satpayev	
Ualiev Zhomart Razkhanovich	PhD	Associate Professor	KazNRTU named after K.I. Satpayev	
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List of abbreviations and symbols

EP - Educational program
LO - Learning outcomes
DG - Digital modeling
ITP - Individual training plan

1. Description of the educational program

The professional activity of the graduates of the program is directed to the field of mathematical and computer modeling, namely the formulation of a mathematical problem, the construction of a model and the implementation by means of computer technologies.

Training of specialists in mathematical and computer modeling will be carried out according to the new educational program (EP) "Digital modeling". The content of the disciplines of the educational program will be developed taking into account the relevant educational programs of the world's leading universities and the international classifier of professional activities in the direction of information technology.

The purpose of creating a specialty is to purposefully train specialists with valuable knowledge in mathematical and computer modeling in a huge mass of specialists in computer science and information technology.

Education involves active research work, participation in scientific projects under the guidance of leading experts in priority areas of science and practice, and cooperation with leading foreign educational and scientific organizations. For students, invited foreign professors (Germany, France, Russia, etc.) can give lectures.

The EP provides for the acquisition of the necessary competencies. In this connection, modern innovative disciplines have been introduced into the program.

The educational program ensures the application of an individual approach to students, the transformation of professional competencies from professional standards and qualification standards into learning outcomes. Student-centered learning is provided - the principle of education, which implies a shift in emphasis in the educational process from teaching (as the main role of the teaching staff in the "transmission" of knowledge) to learning (as an active educational activity of the student).

2. Purpose and objectives of the educational program

Purpose of the EP: The purpose of mastering the educational program "Digital modeling" is:

– formation of systematic knowledge about modern methods of mathematical and computer modeling, their place and role in the system of sciences;

– expansion and deepening of the concepts of mathematics and computer science;

– development of abstract thinking, modeling methods, algorithmic culture and general mathematical and information culture.

Tasks of the EP:

− stimulating the formation of general cultural competencies of a doctoral candidate through the development of a culture of thinking in terms of the application in practice of modern methods of abstract, mathematical and computer modeling, applied mathematics and computer science , as well as computational mathematics;

− expansion of systematized knowledge in the field of modeling, applied mathematics and informatics to provide an opportunity to use knowledge of modern problems of science and education in solving educational and professional problems;
− providing conditions for the activation of the cognitive activity of doctoral students and the formation of their experience in using the methods of mathematical and computer modeling in the course of solving practical problems and stimulating the research activity of doctoral students in the process of mastering the discipline.

3. Requirements for evaluating the educational program learning outcomes

List of competencies

General competencies

- Proficiency in English to search for scientific and technical information; work with scientific and technical literature; oral and written communication with a native speaker on a professional topic and in a real-life situation.
- Possession of critical systems thinking, transdisciplinarity and cross functionality.
- Possession of ICT competencies, the ability to develop software using algorithmic languages.
- Skills: self-study; grooves their knowledge; be open for new information; systems thinking and own judgment.
- The ability to be tolerant of another nationality, race, religion, culture; skill in eating intercultural dialogue.
- Good communication skills, ability to collaborate and work in a team.
- Ability to work in the mode of high uncertainty and rapid change of task conditions; work with consumer requests.
- Possession of a wide public and social, political and professional outlook; ability to use data from various sources and special literature, analyze and critically evaluate historical data and events.
- Possession of the basics of entrepreneurial activity and business economics, readiness for social mobility .

Professional competencies

- Ownership fundamental knowledge in mathematics , mechanics, physics and scientific principles, and the ability to use them in computer simulation .
- The ability to independently develop new algorithms, models and methods for solving technical problems using modern computer technologies.
- Ability to use mathematical and computer models of technological processes for independent research of a wide range of technological problems.
- Ability to develop new algorithms for mathematical and computer modeling and methods for building models for solving technical problems.
- Ability to work with high-tech laboratory and research equipment.
- Knowledge of algorithmic languages and technology programming using object-oriented programming for mathematical and numerical models of technological processes.

- Possession of methods of mathematical modeling, machine learning and computer modeling skills to work as a designer in mechanical engineering, energy, transport, chemical industry.
- Possession of methodology: system analysis; design and decision making in complex and professional situations; ways communications and harmonization points vision; design and presentations analytical and project documentation.
- Ownership willingness organize the work of the research team in area professional activities.
- Ownership the ability to objectively evaluate the results of research and developments, completed others specialists and in others scientific institutions.
- Possession of methods for conducting patent research, licensing And protection copyright rights at creation innovative products in areas professional activities.
- Possession of readiness for teaching activities in this area.

Learning Outcomes

LO1 - Conduct scientific research in the field of mathematical and computer modeling of complex systems, temperature phenomena, thermomechanical processes, as well as apply stochastic and simulation modeling systems to solve research and applied problems.

LO2 - Conduct an analysis of the subject and problem areas and, on its basis, design and develop an intelligent system, apply smart technologies in solving applied problems.

LO3 - Conduct research and experiments using mathematical and numerical tools in solving initial boundary value problems.

LO4 - Be able to create universal engineering methods for computational modeling of fluid mechanics problems.

LO5 - Know and be able to apply the theory of fractals in mathematical modeling.

LO6 - Be able to develop educational materials, educational and methodological complexes of disciplines in the field of mathematical and computer modeling, modern numerical methods, be able to conduct scientific research on a chosen topic agreed with the head of practice and approved at the department, in accordance with the requirements for the organization and content of the research work.

LO7 - Understand scientific research, research methods and methodology, principles of scientific research organization and develop academic writing skills and writing strategies.

Learning strategy

Preparation science-oriented highly qualified personnel higher qualifications new formations, able develop mathematical theory computer simulation, conduct theoretical and experimental research in areas mathematical and computer modeling

that increase the efficiency of these processes in computers, complexes and computer networks, and reducing their time creation, create applied mathematical provision, as well as conduct scientific and teaching activities in the context of global technological trends in basis applications contemporary achievements in areas professional activities.

In process development educational programs formed competencies, allowing realize professional, research and pedagogical activity with considering recent achievements innovative information and educational technologies.

The strategy of the educational program " Digital modeling " is focused on the training of highly qualified specialists with fundamental knowledge in the fields of natural science, mathematical and computer modeling for work in the field of high technologies, taking into account modern trends in the development of science .

In the learning process, special attention is paid to the development of methods of mathematical, numerical and computer modeling, proven software for solving and researching a wide range of engineering problems. To achieve this goal, the structure of classes in almost all profile disciplines includes lectures and practical classes, i.e. theoretical knowledge is firmly fixed by the skills of their practical application.

In the course of the completion of dissertations by graduates in the educational program, the main attention is paid to instilling in graduates the skills to independently or in a team develop physical or virtual models of complex processes and phenomena.

Possession of fundamental knowledge in various fields of science and computer modeling skills will allow graduates to relatively easily integrate into the workflow of almost any industry, to quickly master a wide range of new technologies.

4. Passport of the educational program

4.1. General information

No.	Field name	Comments
1	Code and classification of the field of education	8D06 Information and Communication Technologies
2	Code and classification of training directions	8D061 Information and communication technologies
3	Educational program group	D094 Information technology
4	Educational program name	8D06105 Digital modeling
5	Short description of educational program	The educational program is designed to train specialists in the field of mathematical and computer modeling of various processes and complex systems, to master competitive knowledge and the ability to apply it to create new methods in mathematical and computer modeling of three-dimensional objects and solve applied problems arising in natural sciences, technology, economics, etc. .d.
6	Purpose of EP	The purpose of mastering the educational program "Mathematical and computer modeling" is: – formation of systematic knowledge about

		modern methods of mathematical and computer modeling, their place and role in the system of sciences; – expansion and deepening of the concepts of mathematics and computer science; – development of abstract thinking, modeling methods, algorithmic culture and general mathematical and information culture.
7	Type of EP	doctoral studies
8	The level based on NQF	8D
9	The level based on IQF	8
10	Distinctive features of EP	In the learning process, special attention is paid to conducting scientific research and obtaining new fundamental and applied results using the methods of mathematical, numerical and computer modeling in the analysis and solution of applied and engineering problems.
11	List of competencies of the educational program:	General competencies: - Proficiency in English to search for scientific and technical information; work with scientific and technical literature on mathematical and computer modeling; oral and written communication with a native speaker on a professional topic and in a real life situation. - Possession of critical systems thinking, transdisciplinarity and cross functionality. - Possession of ICT competencies, the ability to develop software using algorithmic languages. - Skills: self-learning; deepening your knowledge; be open to new information; systems thinking and own judgment. - The ability to be tolerant of another nationality, race, religion, culture; ability to conduct intercultural dialogue. - Possession of communication skills, the ability to cooperate and work in a team. - Ability to work in the mode of high uncertainty and rapid change of task conditions; work with consumer requests. - Possession of a broad socio-social, political and professional outlook; the ability to use data from various sources and specialized literature, analyze and critically evaluate historical facts and events. - Possession of the basics of entrepreneurial activity and business economics, readiness for social mobility. Professional competencies: - Possession of fundamental knowledge of mathematics and scientific principles and the ability to use them in solving engineering

		problems. - The ability to independently develop adequate physical and mathematical models of processes and phenomena. - Ability to use mathematical and computer models of mechanical processes for independent study of a wide range of engineering problems of various systems. - Ability to develop new mechanisms and devices, including autonomous mechanisms and robots. - Ability to work with high-tech laboratory and research equipment. - Possession of algorithmic languages and programming technology using object-oriented programming of mathematical and numerical models of physical processes and engineering problems. - Possession of methods of mathematical modeling, machine learning and computer modeling skills to work as a designer in mechanical engineering, energy, transport, chemical production. - Possession of methodology: system analysis; design and decision making in complex and professional situations; ways of communication and coordination of points of view; design and presentation of analytical and project documentation
12	Learning outcomes of the educational program:	- Conduct scientific research in the field of mathematical and computer modeling of complex systems, temperature phenomena, thermomechanical processes, as well as apply stochastic and simulation systems to solve research and applied problems. - Conduct an analysis of the subject and problem area and, on its basis, design and develop an intelligent system, apply smart technologies in solving applied problems. - Conduct research and experiments using mathematical and numerical tools in solving initial-boundary problems for a nonlinear system of moment equations. - Be able to create universal engineering methods for computational modeling of hydromechanics problems. - Know and be able to apply the theory of fractals in mathematical modeling. - Be able to develop educational materials, educational and methodological complexes of disciplines in the field of mathematical and computer modeling, modern numerical

		methods.
13	Education form	full-time
14	Period of training	3 years
15	Amount of credits	180
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree awarded	Doctor of Philosophy (PhD)
18	Developer(s) and authors	Ualiyev Zh., Azhibekova A.S., Lukpanova L.Kh.

4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

№	Discipline name	Short description of discipline	Amount of credits	Formed learning outcomes (codes)						
				LO1	LO2	LO3	LO4	LO5	LO6	LO7
Cycle of general education disciplines University component										
1	Scientific research methods	The concept of science and scientific research, methods and methodology of scientific research, methods of collecting and processing scientific data, principles of organizing scientific research, methodological features of modern science, ways of developing science and scientific research, the role of technical sciences, informatics and engineering research in modern science, structure technical sciences, the application of general scientific, philosophical and special methods of scientific research in theory and practice.	5							V
2	Academic writing	The course aims to develop academic writing skills and writing strategies in doctoral students in the field of engineering and natural sciences. The course focuses on the basics and general principles of academic writing for writing effective sentences and paragraphs; use of tenses in scientific literature, as well as styles and punctuation; writing an abstract, introduction, conclusion, discussion, conclusion, literature and resources used; citations in the text; preventing plagiarism, and preparing a presentation at the conference.	5							V
3	Teaching practice	Teaching special disciplines, organization of educational activities of students, scientific and methodological work on the subject, obtaining skills and abilities in the work of a teacher.	10						V	
Cycle of basic disciplines University component										
4	Intelligent Modeling Systems	Includes fundamental results in two main areas of	5		V					

		modern theory of intelligent control. The first of these are theoretical statements and research methods based on the theory of fuzzy sets and fuzzy logic. The second direction contains a detailed presentation of the issues of description and training of neural networks. At the same time, considerable attention is paid to the algorithmic content of theoretical results and the presentation of methods for analytical and numerical research. relevant tasks of intelligent control systems.								
5	Advanced Machine Learning Methods	The objectives of mastering the discipline: to form theoretical knowledge on the basics of machine learning to build formal mathematical models and interpret modeling results; develop skills in the practical application of machine learning methods for building formal mathematical models and interpreting simulation results when solving applied problems in various applied areas. Machine learning methods is an extensive subsection of artificial intelligence that studies methods for constructing algorithms that can learn.	5		v					
6	Mathematical modeling of physical and chemical processes	Theoretical and practical study of methods and algorithms for mathematical (numerical) problem solving for various technological processes. Development of the ability for critical thinking and analysis of the applicability of modern methods of mathematical modeling of physical and chemical processes. The discipline involves the study of methods for modeling and optimizing basic chemical and technological processes (CTP), as well as specific processes for the production of materials and products .	5	v		v	v			
7	Initial boundary value problems for a nonlinear system of moment equations	The object of study is one-dimensional nonlinear systems of moment Boltzmann equations containing the surface temperature of the aircraft as coefficients. The Boltzmann system of moment equations is intermediate between the kinetic (Boltzmann equation) and hydrodynamic (Euler and Navier-Stokes equations, etc.) levels of describing	5			v	v			

		the state of a gas and represents a nonlinear hyperbolic system of equations in partial derivatives. The problems of approximation of a homogeneous microscopic boundary condition and the Maxwell boundary condition, which depends on the surface temperature of the boundary, for the distribution function in the case of a one-dimensional non-stationary nonlinear Boltzmann equation and the correctness of the initial-boundary value problem for a one-dimensional non-stationary nonlinear system of moment Boltzmann equations in various approximations are studied. In the numerical solution of the problem of determining the characteristics of a gas, such as density, temperature and average velocity, etc., the finite difference method is used.								
8	Numerical modeling of hydromechanical processes	The purpose of studying the discipline is to develop doctoral students' competencies necessary for research and scientific and pedagogical activities in the field of mathematical and numerical modeling of hydromechanics and heat transfer processes, the creation of universal engineering methods for computational modeling of fluid mechanics problems together with associated processes of heat and mass transfer.	5				v			
9	Application of fractal theory in mathematical modeling	To describe complex objects (geometric models of various natural structures), in 1975, the French mathematician Benoit Mandelbrot introduced the concept of a fractal. Fractal objects have a dimension strictly exceeding the topological dimension of the elements from which they are built. The basis of fractal geometry is the idea of self-similarity. This course is an introduction to the geomechanics of fractals.	5	5				v		
10	Research practice	Conducting scientific research by students on the topic chosen, agreed with the head of practice and approved at the Department of Competition Law, in accordance with the requirements for the organization and content of the research work.	10						v	