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

EDUCATIONAL PROGRAM

8D06105 – «Digital modeling»

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 2025

Educational program 8D06105 – «Digital modeling» approved at the meeting of the Academic Council of KazNRTU named after K.I. Satpayev.
Protocol No.10 of «06» March 2025 year.

Considered and recommended for approval at the meeting of the Educational-Methodical Council of KazNRTU named after K.I. Satpayev.
Protocol No. 3 of «20» December 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:				
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Academic Committee members:				
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Employers:				
Viktor Valerievich Verbovskiy	Doctor of Physical and Mathematical Sciences, professor	Deputy General Director for Science	Institute of Mathematics and Mathematical Modeling	
Students				
Moldakalykova Aigul Zhoyamergenovna		Doctoral student	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 the educational program "Digital modeling" is to train doctors of philosophy (PhD) with the relevant competencies of doctors of sciences in the field of digital modeling, specialists who are able to develop a digital double for a physical object or process, and help optimize the efficiency of production.

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.

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	Innovative educational program
8	The level based on NQF	8D
9	The level based on IQF	8
10	Distinctive features of EP	No

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:	LO1 - Understand scientific research, research methods and methodology, principles of scientific research organization and develop academic writing skills and writing strategies. LO2 - Understand the methods, methodology and principles of organization of scientific research. Illustrate the skills and research methods used in the field of digital modeling systems. LO3 - Conduct an analysis of the subject and problem area and, on its basis, design and develop an intelligent system, apply smart technologies and 3D modeling technologies in solving applied problems. LO4 - Be able to visualize the results of machine learning algorithms, choose a machine learning method that matches the research task, and interpret the results. LO5 - 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. LO6 - Conduct research and experiments using mathematical and numerical tools in solving initial boundary value problems. LO7 - To be able to create universal engineering methods for computational modeling of problems for determining gas characteristics using the finite difference method. LO8 - Know and be able to apply the theory of fractals in mathematical modeling. Demonstrate skills in the use of fractals, splash transforms and multi-scale analysis. LO9 - Be able to create universal engineering methods for computational modeling of fluid mechanics problems when creating digital twins of deposits. LO10 - Be able to analyze and predict trends in the training of specialists in the field of intellectual property law in the global market, develop strategies for the protection and commercialization of intellectual property. LO11 - Be able to model and optimize the architecture of an organization, manage processes, evaluate and control the quality of the process of managing changes in the information environment. LO12 - Be able to organize and conduct lectures, seminars and practical classes taking into account the principles of student-centered learning and

		assessment. Be able to develop educational and methodological materials in the disciplines taught, taking into account the integration of education, science and innovation.
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	Azhibekova A.S., Lukpanova L.Kh.

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

№	Name of discipline	Short description of discipline	Amount of credits	Formed learning outcomes (codes)											
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12
Cycle of basic disciplines University component															
1	Academic writing	Objective: to develop academic writing skills and writing strategies for doctoral students in engineering and natural sciences. Content: fundamentals and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, and references; in-text citation; preventing plagiarism; and preparing a conference presentation.	5	v											v
2	Methods of scientific research	Purpose: It consists in mastering knowledge about the laws, principles, concepts, terminology, content, specific features of the organization and management of scientific research using modern methods of scientometry. Contents: structure of technical sciences, application of general scientific, philosophical and special methods of scientific research, principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, computer science and engineering research in theory and practice.	5	v	v										
Cycle of basic disciplines Component of choice															
3	Intellectual property and the global market	Purpose: the goal is to train specialists in the field of intellectual property law who can analyze and predict trends in its development in the global market, develop strategies for the protection and commercialization of intellectual property. Contents: global aspects of intellectual property and its role in	5										v		v

		international trade and economics, analysis of international agreements and conventions, IP management strategies, cases of protection and violation of intellectual property rights in various jurisdictions.													
4	Intelligent Modeling Systems	Purpose: familiarization with the concept and current state of development of intelligent systems; control methods that allow the formation of complex chains of purposeful behavior of intelligent systems. Content: formation of a systematic approach to the design and development of intelligent systems using modern models of knowledge representation and processing, including intelligent control systems; training in the practical application of intelligent systems to solve current problems, including the identification and cognitive visualization of areas of interest, recognition of graphic images, dynamic planning and the formation of complex behavior in conditions of disturbances.	5			v								v	
5	Advanced Machine Learning Methods	Purpose: developing skills in the practical application of machine learning methods for constructing formal mathematical models and interpreting modeling results when solving problems in various applied areas. Content: theoretical knowledge of the basics of machine learning for building formal mathematical models and interpreting simulation results; machine learning methods, methods for constructing algorithms that can learn.	5				v					v			
Cycle of profile disciplines Component of choice															
6	Mathematical modeling of physical and chemical processes	Purpose: development of the ability for critical thinking and analysis of the applicability of modern methods of mathematical modeling of physical and chemical processes. Content: theoretical and practical study of methods and algorithms for mathematical (numerical) problem solving for various technological processes. Study of methods for modeling and optimization of basic chemical technological processes, as well as specific processes for the	5					v		v					

		production of materials and products.													
7	Initial boundary value problems for a nonlinear system of moment equations	Purpose: study of nonlinear systems of Boltzmann moment equations containing the surface temperature of the aircraft as a coefficient. Content: nonlinear hyperbolic system of partial differential equations; questions of approximation of a homogeneous microscopic boundary condition and Maxwell's boundary condition for the distribution function in the case of a one-dimensional nonstationary nonlinear Boltzmann equation and the correctness of the initial boundary value problem for a one-dimensional nonstationary nonlinear system of Boltzmann moment equations in various approximations. Application of the finite-difference method for the numerical solution of the problem of determining gas characteristics, such as density, temperature and average speed.	5						v	v					
8	Application of the theory of fractals in mathematical modeling	Purpose: in-depth study of fractal sets, their properties, methods of research and construction, acquisition of knowledge about the possibility of describing many natural processes and phenomena using the theory of fractals. Content: new effective ways of mathematical description of complex phenomena, methods of fractal analysis of time series; dimension of fractal objects; possibilities of practical application of the ideas of fractal geometry.	5								v				
9	Numerical modeling of hydromechanical processes	Purpose: formation of competencies necessary for research and scientific-pedagogical activities in the field of mathematical and numerical modeling of fluid mechanics and heat transfer processes. Content: processes of fluid mechanics and heat transfer, creation of universal engineering methods for computational modeling of fluid mechanics problems together with associated processes of heat and mass transfer.	5							v		v			

5. Curriculum of educational program

SATBAYEV UNIVERSITY

«APPROVED»
Decision of the Academic Council
NPJSC«KazNRTU
named after K.Satbayev»
dated 06.03.2025 Minutes № 10

WORKING CURRICULUM

Academic year	**2025-2026 (Autumn, Spring)**
Group of educational programs	**D094 - "Information technologies"**
Educational program	**8D06105 - "Digital modeling"**
The awarded academic degree	**Doctor of Philosophy PhD**
Form and duration of study	**full time (scientific and pedagogical track) - 3 years**

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters						Prerequisites
									1 course		2 course		3 course		
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)															
CYCLE OF BASIC DISCIPLINES (BD)															
M-1. Module of basic training															
LNG305	Academic writing		BD, UC	5	150	0/0/45	105	E	5						
CSE339	Research methodology		BD, UC	5	150	30/0/15	105	E	5						
MAT309	Intelligent Modeling Systems	1	BD, CCH	5	150	30/0/15	105	E	5						
MAT310	Advanced Machine Learning Methods	1	BD, CCH	5	150	30/0/15	105	E	5						
MNG349	Intellectual property and the global market	1	BD, CCH	5	150	30/0/15	105	E	5						
M-3. Practice-oriented module															
AAP350	Pedagogical practice		BD, UC	10				R		10					
CYCLE OF PROFILE DISCIPLINES (PD)															
M-2. Module of professional activity															
MAT311	Mathematical modeling of physical and chemical processes	1	PD, CCH	5	150	30/0/15	105	E	5						
MAT312	Initial boundary value problems for a nonlinear system of moment equations	1	PD, CCH	5	150	30/0/15	105	E	5						
MAT314	Numerical modeling of hydromechanical processes	2	PD, CCH	5	150	30/0/15	105	E	5						
MAT313	Application of the theory of fractals in mathematical modeling	2	PD, CCH	5	150	30/0/15	105	E	5						
M-3. Practice-oriented module															
AAP355	Research practice		PD, UC	10				R			10				
M-4. Experimental research module															
AAP336	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	5				R	5						
AAP347	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	20				R		20					
AAP347	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	20				R			20				
AAP356	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	30				R				30			
AAP356	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	30				R					30		
AAP348	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	18				R						18	
M-5. Module of final attestation															
ECA325	Final examination (writing and defending a doctoral dissertation)		FA	12										12	
Total based on UNIVERSITY:									30	30	30	30	30	30	

	60	**60**	**60**	

Number of credits for the entire period of study

Cycle code	Cycles of disciplines	Credits			
		Required component (RC)	University component (UC)	Component of choice (CCH)	Total
GED	Cycle of general education disciplines	0	0	0	0
BD	Cycle of basic disciplines	0	20	5	25
PD	Cycle of profile disciplines	0	10	10	20
Total for theoretical training:		**0**	**30**	**15**	**45**
RWDS	Research Work of Doctoral Student				123
ERWDS	Experimental Research Work of Doctoral Student				0
FA	Final attestation				12
TOTAL:					**180**

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 4 dated 22.11.2024

Signed:

Governing Board member - Vice-Rector for Academic Affairs	Uskenbayeva R. K.
Approved:	
Vice Provost on academic development	Kalpeyeva Z. Б.
Head of Department - Department of Educational Program Management and Academic-Methodological Work	Zhumagaliyeva A. S.
acting Director of Institute - Institute of Automation and Information Technologies	Chinibayev Y. Г.
Department Chair - Higher Mathematics and Modeling	Tuleshova G. .
Representative of the Academic Committee from Employers ____Acknowledged____	Verbovskiy V. V.