



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

EDUCATIONAL PROGRAM

8D06105 - Digital modeling

Code and Classification of Education Area:

8D06 Information and Communication Technology

Code and classification of areas of training:

8D061 Information and Communication Technologies

Group of educational programs:

D094 Information Technology

Level based on NQF: 8

Level based on IQF: 8

Study period: 3 years

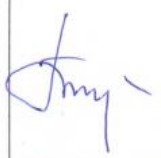



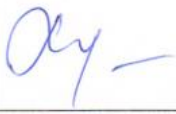


Amount of credits: 180

Almaty, 2023

Educational program 8D06105 «Digital modeling» was approved at the meeting of the Academic Council of KazNRTU named after K.I. Satbayev
Protocol No.15 of May 04, 2023.

Considered and recommended for approval at the meeting of the Educational and Methodological Council of KazNRTU named after K.I. Satbayev
Protocol No. 6 of April 20, 2023.

Educational program 8D06105 «Digital modeling» was developed by the Academic committee in the direction 8D061 "Information and communication technologies".

Name and surname	Degree/ Academic title	Position	Place of work	Sign
Chairman of the Academic Committee:				
Tuleshov Amandyk Kuatovich	Doctor of technical sciences / Professor	CEO	Institute of Mechanics and Engineering named after academician U.A. Dzholdasbekov, +7 (727) 2726270	
Academic committee members:				
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List of abbreviations and symbols

EP - Educational program
LO - Learning outcomes
DM - 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.

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 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.
7	Type of EP	Innovative EP
8	The level based on NQF	8
9	The level based on IQF	8
10	Distinctive features of EP	No
11	List of competencies of the educational program:	<p>General competencies:</p> <ul style="list-style-type: none"> - 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;

		<p>work with consumer requests.</p> <ul style="list-style-type: none"> - 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. <p>Professional competencies:</p> <ul style="list-style-type: none"> - 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:	<p>LO1 – Understand scientific research, research methods and methodology, principles of scientific research organization and develop academic writing skills and writing strategies.</p> <p>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.</p> <p>LO3 – Conduct an analysis of the subject and</p>

		<p>problem area and, on its basis, design and develop an intelligent system, apply smart technologies and 3D modeling technologies in solving applied problems.</p> <p>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.</p> <p>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.</p> <p>LO6 – Conduct research and experiments using mathematical and numerical tools in solving initial boundary value problems.</p> <p>LO7 – To be able to create universal engineering methods for computational modeling of problems for determining gas characteristics using the finite difference method.</p> <p>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.</p> <p>LO9 – Be able to create universal engineering methods for computational modeling of fluid mechanics problems when creating digital twins of deposits.</p>
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	Tuleshov A.K., Tulesheva G.A., Ualiev Zh.R., Azhibekova A.S., Lukpanova L.Kh., Sakabekov A.S., Hikmetov A.K., Orazaly Zh.N., Dzhumadilov E.A.

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	Academic writing	The course is aimed at developing academic writing skills and writing strategies for 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; using tenses in scientific literature, as well as styles and punctuation; writing abstracts, introductions, conclusions, discussions, conclusions, literature and resources used; quoting in the text; preventing plagiarism, and making presentations at a conference.	5	v						
2	Research methods	The course contributes to the formation of knowledge about the methods, methodology of scientific research, methods of collecting and processing scientific data, the principles of the organization of scientific research, the role of technical sciences, computer science and engineering research in modern science. The structure of technical sciences, the application of general scientific, philosophical, special methods of scientific research in theory and in practice are considered.	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 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.	5			v				

		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.								
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				✓			
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-technological processes (CTP), as well as specific processes for the production of materials and products.	5					✓		
7	Initial boundary value problems for a nonlinear system of moment equations	The problems of approximation of the homogeneous microscopic boundary and boundary conditions of Maxwell, depending on the surface temperature of the boundary, for the distribution function in the case of a one-dimensional non-stationary nonlinear Boltzmann equation, 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, a finite-difference method is used.	5						✓	✓

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 the theory of fractals in mathematical modeling	The objectives of mastering the discipline "Application of the theory of fractals in mathematical modeling" are an in-depth study of fractal sets, their properties, methods of research and construction, the acquisition of knowledge about the possibility of describing many natural processes and phenomena using the theory of fractals and the possibility of practical application of the ideas of fractal geometry.	5								
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	

5. Curriculum of educational program



**SATBAYEV
UNIVERSITY**

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATBAYEV



APPROVED

Chairman of the Management Board-

Rect. of Kazim named after K.Satpayev

M.M. Begentaev

05 2023

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year

Educational program 8D06105 - "Digital modeling"
Group of educational programs M094 - "Information Technology"

Form of study: full-time		Duration of study: 3 year			Academic degree: Doctor of Philosophy PhD								
Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters					
								1 course		2 course		3 course	
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
CYCLE OF BASIC DISCIPLINES (BD)													
M-1. Module of basic training (university component)													
MET322	Scientific research methods	BD UC	5	150	2/0/1	105	E	5					
LNG305	Academic writing	BD UC	5	150	0/0/3	105	E	5					
component of choice													
MAT309	Intelligent Modeling Systems												
MAT310	Advanced Machine Learning Methods	BD CCHBD CCH	5	150	2/0/1	105	E	5					
CYCLE OF PROFILE DISCIPLINES (PD)													
M-2. Module of professional activity (component of choice)													
MAT311	Mathematical modeling of physical and chemical processes	ПД, KB	5	150	2/0/1	105	E	5					
MAT312	Initial boundary value problems for a nonlinear system of moment equations												
MAT314	Numerical modeling of hydromechanical processes	ПД, KB	5	150	2/0/1	105	E	5					
MAT313	Application of fractal theory in mathematical modeling												
M-3. Practice-oriented module													
AAP350	Pedagogical practice	BD UC	10						10				
AAP355	Research practice	PD UC	10							10			
M-4. Experimental research module													
AAP336	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	5					5					
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40						20	20			
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60								30	30	
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	18										18
M-5. Module of final attestation													
ECA303	Writing and defending a doctoral dissertation	FA	12										12
Total based on UNIVERSITY:								30	30	30	30	30	30
								60		60		60	

NON-PROFIT JOINT STOCK COMPANY "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY
named after K.I. SATBAEV"

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines		20	5	25
PD	Cycle of profile disciplines		10	10	20
	<i>Total for theoretical training:</i>	<i>0</i>	<i>30</i>	<i>15</i>	<i>45</i>
	RWDS				123
FA	Final attestation	12			12
	TOTAL:	12	30	15	180

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol №15 04.05.2023 y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol №6 20.04.2023 y.

Decision of the Academic Council of the Institute of Automation and Information Technology. Protocol №9 31.03.2023 y.

Vice-Rector for Academic Affairs

Director of the Institute of Automation
and Information Technology

Head of the Department of Higher
Mathematics and Modeling

Specialty Council representative from
employers

B.A. Zhautikov

R.K. Uskenbaeva

G.A. Tulesheva

A.K. Tuleshov

Выписка
из протокола № 15 заседания Ученого совета КазННТУ имени К.И.Сатпаева

«04» мая 2023 г.

г. Алматы

ПОВЕСТКА ДНЯ

5. Об утверждении новых образовательных программ.

Ускенбаева Р.К., директор Института автоматизации и информационных технологий, внесла на рассмотрение Ученого совета материалы по вопросу об утверждении новых образовательных программ на 2023 – 2024 учебный год: 8D061-Digital Modeling, 7M06 -Digital Modeling.

Были представлены выписки из протоколов заседаний кафедры «Высшая математика и моделирование», УС ИАиИТ, УМС университета, рецензии.

Ученый совет

ПОСТАНОВИЛ:

5.1 Утвердить новую образовательную программу 7M06 – «Digital Modeling» – ГОП M094 – «Информационные технологии». Направление подготовки: 7M061– «Информационно-коммуникационные технологии».

5.2 Утвердить новую образовательную программу 8D06 – «Digital Modeling» – ГОП D094 – «Информационные технологии». Направление подготовки: 8D061– «Информационно-коммуникационные технологии».

5.3 Кафедре «Высшая математика и моделирование» в установленном порядке провести работы по открытию в университете ОП 7M06 – «Digital Modeling», ОП 8D06 – «Digital Modeling».

Главный ученый секретарь



К. Турмагамбетова

«К.И. СӘТБАЕВ АТЫНДАҒЫ
КАЗАҚ ҰЛТТЫҚ ТЕХНИКАЛЫҚ ЗЕРРТЕУ
УНИВЕРСИТЕТІ» КОММЕРЦИЯЛЫҚ ЕМЕС
АКЦИОНЕРЛІК ҚОҒАМЫ

НЕКОММЕРЧЕСКОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО
«КАЗАХСКИЙ НАЦИОНАЛЬНЫЙ
ИССЛЕДОВАТЕЛЬСКИЙ ТЕХНИЧЕСКИЙ
УНИВЕРСИТЕТ» ИМЕНИ К.И. САТБАЕВА»

«20» 04. 2023 ж.
Алматы қаласы

«20» 04. 2023 г.
город Алматы

ВЫПИСКА ИЗ ПРОТОКОЛА № 6
заседания Учебно-методического совета

Председатель – Бегентаев М.М., председатель Правления - Ректор.
Секретарь – Нарбаев М.Т.

ПОВЕСТКА ДНЯ

4 Разное

4.3 Об открытии новых образовательных программ

4.3.3 ОП 7М06 - «Digital modeling» - ГОП М094 – «Информационные технологии».

Направление образования: 7М061 Информационно-коммуникационные технологии

Докладчик: Уалиев Жомарт Разханович профессор кафедры Высшей математики и моделирования (ИЛиИТ)

ВЫСТУПИЛ: Жаутиков Б.А. Считаю ОП актуальной, соответствует Атласу новых профессий. Выношу на голосование.

Результаты голосования:

«За» – 26; «Против» – 1; «Воздержались» – 0.

ВЫСТУПИЛ: Жаутиков Б.А. принято, большинством голосов.

ПОСТАНОВИЛИ: Рекомендовать на рассмотрение Ученого Совета КазНТУ имени К.И.Сатпаева вопрос об открытии новой ОП 7М06 - «Digital modeling» - ГОП М094 – «Информационные технологии». Направление образования: 7М061 Информационно-коммуникационные технологии.

Секретарь УМС



М. Нарбаев