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

EDUCATIONAL PROGRAM
6B06103 «Mathematical and computer modeling»

Code and classification of the field of education:
6B06 «Information and Communication Technologies»
Code and classification of training directions:
6B061 «Information and Communication Technologies»
Group of educational programs: **B057 «Information technologies»**
Level on NQF: **6**
Level on IQF: **6**
Period of study: **4 years**
Volume of the credits: **240**

Almaty 2025

NCJS "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY"
named after K.I. SATPAEV"

Educational program 6B06103 «Mathematical and computer modeling» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council
Protocol No. 10 of 06.03.2025 year.

Was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council
Protocol No. 3 of 20.12.2024 year.

Educational program 6B06103 «Mathematical and computer modeling»
was developed by Academic committee based on direction «Information technologies».

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairman of the Academic Committee:				
Tulesheva Gulnara Alipovna	Candidate of Physical and Mathematical Sciences/Assistant professor	Head of Department of «Higher Mathematics and Modeling»	NCJS «KazNRTU named after K.I. Satbayev»	
Teaching staff:				
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Students:				
Bulekpayev Zhunisbek		2rd year student of EP 6B06103 "Mathematical and computer modeling"	NCJS «KazNRTU named after K.I. Satbayev»	
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List of abbreviations and designations

EP – educational program
BC – basic competencies
PC – professional competencies
LO – Learning outcomes
MOOC – massive open online courses
NQF – National Qualifications Framework
IQF – Industry Qualifications Framework

1. Description of the educational program

The educational program 6B06103 "Mathematical and computer modeling" is aimed at teaching students general education, basic and specialized disciplines with the achievement of appropriate competencies.

The OP is based on the state educational standard for higher professional education; on the professional standard.

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 opportunity to apply it to create new methods and knowledge in mathematical and computer modeling of three-dimensional objects, and to solve applied problems arising in physics, chemistry, biology, economics, etc. Specialists will also be able to simulate various tasks arising in theoretical computer science.

The content of the disciplines of the educational program has been developed taking into account the relevant educational programs of the world's leading universities, the international classifier of professional activity in the field of information and communication technologies.

Graduates of the educational program 6B06103 "Mathematical and computer modeling" are focused on the formulation of a mathematical problem, model construction and implementation through computer technology, as well as the application of acquired knowledge in the analysis of various problems arising in the field of physics, economics, finance, biology, computer science and engineering.

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 assumes a shift in emphasis in the educational process from teaching (as the main role of the teaching staff in the "translation" of knowledge) to teaching (as an active educational activity of the student).

In case of successful completion of the full bachelor's degree course, the graduate is awarded a bachelor's degree in information and communication technologies according to the educational program 6B06103 "Mathematical and computer Modeling".

2. Purpose and objectives of educational program

The purpose of the OP: The curriculum program is created with the focus on training competitive professionals in computer science and information technologies, which will possess the valuable knowledge in such future technologies as artificial intelligence and hence will be distinguished on the international IT market.

As a result of completing their studies, graduates will be able to work as specialists in the field of technologies for building and researching mathematical models of a wide variety of systems and processes that allow them to predict the evolution of the systems under study, and thereby verify the correctness of decisions made.

Tasks of the OP:

 training of a competitive generation of technical specialists in the field of mathematical and computer modeling for the labor market, proactive, able to work in a team, possessing high personal and professional competencies;

 integration of educational and scientific activities;

Establishing partnerships with leading universities in the near and far abroad in order to improve the quality of education;

expansion of relations with customers of educational services, employers in order to determine the quality requirements for training specialists, conducting courses, seminars, master classes, internships, production practices.

The content of the educational program 6B06103 "Mathematical and computer modeling" is implemented in accordance with the credit technology of education and is carried out in the state, Russian and English languages.

The educational program will make it possible to implement the principles of the Bologna process. Based on the students' choice and independent planning of the sequence of studying disciplines, they independently form an individual study plan (IUP) for each semester according to the Working Curriculum and the Catalog of elective disciplines. The educational program has increased the volume of mathematical, natural science, basic and language disciplines.

The following disciplines are studied: "Information and communication Technologies", "Algorithmization and programming in Python", "Computer modeling of engineering problems", "Algorithms, data structures and programming", "Mathematical models in neural networks", "Mathematical and computer modeling of chemical, technological and physical processes", "Geometric modeling based on OpenGL", "Elements of Data Science", "Mathematics of Cryptography", "Advanced Machine Learning Algorithms", "Asymptotic optimal Control methods", etc.

Undergraduates practice in commercial, government and departmental structures. According to the academic mobility program, the best students have the opportunity to study at leading foreign universities in the relevant field.

3. Requirements for the evaluation of educational program learning outcomes

The educational program has been developed in accordance with the State Mandatory Standards of Higher and Postgraduate Education, approved by Order No. 2 of the Minister of Science and Higher Education of the Republic of Kazakhstan dated July 20, 2022 (registered in the Register of State Registration of Normative Legal Acts under No. 28916) and reflects the learning outcomes on the basis of which curricula are developed (working curricula, individual curricula of students) and working curricula in disciplines (syllabuses).

Mastering disciplines of at least 10% of the total volume of credits of the educational program using MOOC on the official platform https://polytechonline.kz/cabinet/login/index.php /, as well as through the study of disciplines through the international educational platform Coursera https://www.coursera.org /.

The assessment of learning outcomes is carried out according to the developed tasks within the framework of the educational program in accordance with the requirements of the state mandatory standard of higher and postgraduate education.

When evaluating learning outcomes, uniform conditions and equal opportunities are created for students to demonstrate their knowledge, skills and abilities.

4. Passport of educational program

4.1. General information

№	Field name	Note
1	The code and classification of the field of education	6B06 "Information and communication technologies"
2	The code and classification of training areas	6B061 "Information and communication technologies"
3	Group of educational programs	B057 "Information technology"
4	Name of the educational program	6B06103 "Mathematical and computer modeling"
5	A brief description of the educational program	6B06103 "Mathematical and computer modeling" is aimed at teaching students general education, basic and specialized disciplines with the achievement of appropriate competencies. The OP is based on the state educational standard for higher professional education; on the professional standard. 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 opportunity to apply it to create new methods and knowledge in mathematical and computer modeling of three-dimensional objects, and to solve applied

		problems arising in physics, chemistry, biology, economics, etc. Specialists will also be able to simulate various tasks arising in theoretical computer science. The content of the disciplines of the educational program has been developed taking into account the relevant educational programs of the world's leading universities, the international classifier of professional activity in the field of information and communication technologies. Graduates of the educational program 6B06103 "Mathematical and computer modeling" are focused on the formulation of a mathematical problem, model construction and implementation through computer technology, as well as the application of acquired knowledge in the analysis of various problems arising in the field of physics, economics, finance, biology, computer science and engineering. 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 assumes a shift in emphasis in the educational process from teaching (as the main role of the teaching staff in the "translation" of knowledge) to teaching (as an active educational activity of the student).
6	The purpose of the Educational program	The purpose of the educational program is to purposefully train specialists with valuable knowledge of future technologies – artificial intelligence technologies that will favorably distinguish them in the international IT services market.
7	type of educational program	New
8	The level of the NQF	6
9	Level by IQA	6
10	Distinctive features of the Educational Program	No
11	The list of competencies of the educational program:	Basic competencies: - English language proficiency for: searching for scientific and technical information; working with scientific and technical literature; oral and written communication with a native speaker on a professional topic and in a real life situation. - Mastery of critical systems thinking, transdisciplinarity and cross-functionality. - Knowledge of ICT competencies, the ability to develop software using algorithmic languages. - Mastery of skills: self-study; deepening one's knowledge; being open to new information; systemic thinking and one's own judgment.

		- The ability to be tolerant of another nationality, race, religion, culture; the ability to conduct an intercultural dialogue. - Possession of communication skills, the ability to cooperate and work in a team. - The ability to work in a mode of high uncertainty and rapid change of task conditions; to work with consumer requests. - Knowledge of a broad socio-social, political and professional outlook; the ability to use data from various sources and special literature, analyze and critically evaluate historical facts and events. - Knowledge of the basics of entrepreneurship and business economics, readiness for social mobility. Professional competencies - Possession of fundamental knowledge in mathematics, physics and scientific principles and the ability to use them in solving engineering problems. - The ability to independently develop adequate physical and mathematical models, computer modeling algorithms. - The ability to use mathematical and computer models of technological processes for independent research. - The ability to develop new mathematical models of information technology. The ability to work with high-tech laboratory and research equipment. Knowledge of algorithmic languages and programming technology using object-oriented programming of mathematical and numerical models of physical processes and engineering problems. Knowledge of mathematical modeling and machine learning methods and computer modeling skills to work as a designer in mechanical engineering, energy, transport, chemical production. – Knowledge of methodology: system analysis; design and decision-making in complex and professional situations; methods of communication and coordination of points of view; design and presentation of analytical and project documentation.

12	Learning outcomes of the educational program:	LO1: to know official etiquette and be able to use it; to know the basic regulatory framework of the state, the basic regulatory framework in the field of human and civil rights protection, etc., to know the basics of financial management, the quality management system; to be able to identify key issues of business strategies of the organization; to know the issues of financial mathematics in terms of certainty, as well as in uncertainty, optimal portfolio theory, including

		probability-theoretic methods and financial risks; possess the skills of: various methods of calculating interest, finding generalizing characteristics of payment flows, methods for determining the effectiveness of short-term instruments and long-term financial transactions, including industrial investments and bonds, analyzing, synthesizing and designing their theoretical knowledge to solve financial problems. LO2: to demonstrate the skills of managing R&D and production job using modern equipment, instruments, software and information technologies based on the principles of entrepreneurship and leadership, anti-corruption policy and life safety. LO3: have knowledge on research methodologies, communicative and human principles of life, and on project and human resource management models; be able to analyze technical documentation, extract from it the information necessary to solve the task. LO4: to defend and prove your own at assessment of innovative domestic or foreign experience at the formation of an original judgment on a professional problem and conduct ethical interpersonal communication with public speaking skills and the ability to work in a team. LO5: to know the theoretical foundations of human life safety in the environment, legal and regulatory and technical foundations of life safety; be able to use theoretical knowledge of the fundamentals and economics of environmental management in the analysis of sustainable development, competently present basic information in the field of ecology and environmental management. LO6: know the algorithms and how to represent them, main classes from the Python programming language class library for creating object-oriented applications; be able to use classes and modules from Python libraries; have the skills to develop console applications in the style of object-oriented programming, programming numerical methods for solving problems of linear algebra, differential equations, nonlinear equations and systems of equations. LO7: to know the main types of data structures used in solving problems, algorithms for processing information stored in various types of data structures; to apply data structures and algorithms for their processing in solving various problems. LO8: know the main types of linear integral equations of Fredholm, Volterra, equations with a weak singularity and problems leading to these integral equations; know the theory of groups, rings and fields; be able to apply in practice methods for solving integral equations in limited domains; understand and apply in practice the reduction of problems for ordinary differential equations and problems for equations of mathematical physics to integral equations and methods for solving them; be able to find, analyze and contextually process

		scientific and technical information related to integral equations and methods for constructing their solutions; demonstrate the ability to analyze and synthesize applications of integral equations; be able to use abstract algebraic structures for specific calculations. LO9: to know the ways of defining curves, surfaces, three-dimensional geometric objects, the basic methods of their image in various environments, visualization methods for solving geometric and dynamic problems, classical methods used in geometric modeling; to possess mathematical apparatus, information and computer technologies necessary to solve the tasks; be able to create 3D models of objects. LO10: Have knowledge of the basics of information theory, architecture of computing systems, theory of algorithms and programming; apply the laws of algebra of logic; determine the types of graphs and give their characteristics; build the simplest automata; to know the basic concepts and techniques of discrete mathematics, logical operations, formulas of logic, laws of algebra of logic, basic classes of functions, completeness of a set of functions, basic concepts of set theory, set-theoretic operations and their connection with logical operations, predicate logic, binary relations and their types, elements of mapping theory and substitution algebra, method of mathematical induction, algorithmic enumeration of basic combinatorial objects, elements of automata theory. LO11: to know the basics of fundamental disciplines such as mathematics and physics, to be able to apply the main mathematical and physical theories to specific problems; to know the basics of information technologies and modern software tools for conducting engineering analysis, the principles of constructing computer models; to be able to apply the basic concepts and laws of mechanics, and the methods derived from these laws for studying the equilibrium and motion of a material point, a rigid body, and a mechanical system in professional activities. LO12: be able to build a mathematical model of a phenomenon or process; be able to use mathematical packages such as MatLab, MATHEMATICA to find, analyze and graphically represent solutions to mathematical models, know the basic capabilities of the SIMULINK mathematical modeling package, and computational error; to know numerical methods for solving problems of linear algebra, differential equations, methods for solving nonlinear equations and systems of equations. LO13: to know the basic mathematical concepts and methods necessary for developing the skills to solve problems in professional activities: methods of linear algebra and analytical geometry; differential calculus of single and multiple-variable functions; integral calculus of single and multiple-variable

		functions; methods of solving differential equations; basic methods of probability theory and mathematical statistics; optimization methods; problems of discrete, integer, nonlinear, and linear programming; methods of constructing an optimal plan. LO14: apply machine learning algorithms for data analysis and management, business process analysis, formation of technical requirements and specifications, TensorFlow library for image analysis; know modern programming languages, operating systems, database management systems, various software development technologies, modern methods of data storage, analysis, processing and interpretation, basic tools of artificial intelligence the main areas of application of artificial intelligence systems. LO15: know the basic concepts of cryptography; basic requirements for cryptographic protection systems; basic cryptographic protection algorithms; be able to formulate information security tasks; use modern information security tools; apply protection methodologies in the field of information security. LO16: know the architecture of multilayer unidirectional neural networks, methods and basic algorithms for their training; methods of collecting and preprocessing data used for training and testing; methods for evaluating the quality of neural network training; the structure of deep, hybrid and fuzzy neural networks; basic principles of designing data processing systems using artificial neural networks; be able to model single-layer and multi-layer unidirectional neural networks in the MATLAB environment/Neulal Networks Toolbox; solve typical data processing problems using neural network models (classification, recognition, forecasting); apply fuzzy and neural network models in applied tasks.
13	The form of education	Full-time
14	The duration of the training	4
15	Volume of loans	240
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree awarded	Bachelor's Degree in Information and Communication Technology
18	Developers and authors:	Candidate of Physical and Mathematical Sciences Tulesheva G.A., Doctor of Physical and Mathematical Sciences Sakabekov A., senior lecturer Ergazina R.A.

4.2. Relationship between the achievability of the formed learning outcomes according to educational program and academic disciplines

№	Name of the discipline	A brief description of the discipline	Number of credits	Generated learning outcomes (codes)															
				LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9	LO10	LO11	LO12	LO13	LO14	LO15	LO16
The cycle of general education disciplines Component of choice																			
1	Fundamentals of anti-corruption culture and law	Purpose: to increase the public and individual legal awareness and legal culture of students, as well as the formation of a knowledge system and a civic position on combating corruption as an antisocial phenomenon. Contents: improvement of socio-economic relations of the Kazakh society, psychological features of corrupt behavior, formation of an anti-corruption	5	v	v														

		culture, legal responsibility for acts of corruption in various fields.																	
2	Fundamentals of scientific research methods	Purpose: to form knowledge about scientific research, methods and methodology of scientific research, methods of collecting and processing scientific data in modern science. Contents: fundamentals of the theory of solving inventive problems, with algorithmic methods of searching for technical solutions and their optimization, basic mathematical optimization methods, the use of artificial intelligence capabilities to solve optimization	5			**v**	**v**												

		problems, issues of search, accumulation and processing of scientific information.																	
3	Basics of Financial Literacy	Purpose: formation of financial literacy of students on the basis of building a direct link between the acquired knowledge and their practical application. Contents: using in practice all kinds of tools in the field of financial management, saving and increasing savings, competent budget planning, obtaining practical skills in calculating, paying taxes and correctly filling out tax reports, analyzing financial information,		v	v														

		orienting in financial products to choose adequate investment strategies.																	
4	Fundamentals of Economics and entrepreneurship	Purpose: To develop basic knowledge of economic processes and skills in entrepreneurial activities. Content: The course aims to develop skills in analyzing economic concepts such as supply and demand, and market equilibrium. It includes the basics of creating and managing a business, developing business plans, risk assessment, and strategic decision-making.	5	v	v														
5	Ecology and life safety	Purpose: formation of ecological knowledge and	5		v			v											

		consciousness, obtaining theoretical and practical knowledge on modern methods of rational use of natural resources and environmental protection. Contents: the study of the tasks of ecology as a science, the laws of the functioning of natural systems and aspects of environmental safety in working conditions, environmental monitoring and management in the field of its safety, ways to solve environmental problems; life safety in the technosphere, emergencies of a																	

		natural and man-made nature.																	
The cycle of basic disciplines The university component																			
6	Mathematical Analysis I	Purpose: consideration of the limits of a function of one variable, differentiability, theory of a complete study of the function. Contents: real numbers; limit of a numerical sequence; functions; limit of a Cauchy and Heine function; one-sided limits; continuity of a function; Cantor's theorem; derivative, differential, geometric meanings; invariance of the form of the first	5													**v**			

		differential; derivatives and differentials of higher order; conditions of stability and monotony; largest and smallest values; complete study of a function using a derivative, plotting.																	
7	Mathematical Analysis II	Purpose: to consider indefinite, definite, improper integrals of a function of one variable and the theory of their application. Contents: complex numbers; antiderivative and indefinite integral of a function of one variable; method of integration by parts; integration of rational fractions, irrational functions,	5													**v**			

		trigonometric functions; definite integral; improper integrals; application of the definite integral in geometry and physics; calculating the area of a flat figure; calculation of the volume of an arc of a curve on a plane, a body of revolution; Numerical methods for calculating the definite integral.																	
8	Mathematical Analysis III	Purpose: to give basic knowledge of the differential and integral calculus of a function of many variables. Contents: Differentialб integral calculus of functions of many variables. Curvilinear,	5													v			

		doubleб multiple integrals; integrals over the surface and over the volume; mean value theorems; Fourier seriesб integrals. Applications of differential and integral calculus of functions of many variables in mechanics and engineering.																	
9	Mathematical analysis IV	Purpose: to develop skills in analyzing functions of many variables using infinitesimal quantities, to master concepts related to functions of many variables. Contents: curved integrals of the first type, conditions for the independence of a curved integral from a path,	6													v			

		closed-loop integrals, calculation of a double integral, Green's formula, surface integrals, Stokes formula and its application, triple and multiple integrals, Gauss-Ostrogradsky's formula, elements of vector analysis.																	
10	Physics I	Purpose: to study the basic physical phenomena and laws of classical and modern physics; methods of physical research; the influence of physics on the development of technology; the relationship of physics with other sciences and its role in solving scientific and technical problems	5										**v**					

		of the specialty. Contents: mechanics, dynamics of rotational motion of a solid body, mechanical harmonic waves, fundamentals of molecular-kinetic theory and thermodynamics, transfer phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell's equations.																	
11	Physics II	Purpose: to form students' knowledge and skills in using fundamental laws, theories of classical and modern physics, as well as methods of physical research	5											v					

		as the basis of a system of professional activity. Contents: harmonic oscillations, damped oscillations, alternating current, wave motion, laws of refraction and reflection of light, quantum optics, laws of thermal radiation, photons, their characteristics, wave function, electrical conductivity of metals, atomic nucleus, its structure and properties, binding energy, radioactivity.																
12	Algorithmization and programming in Python	Purpose: to develop students' skills to formulate the principles of creating programs	4						v	v									

		and methods of their implementation in Python using algorithms, data structures and operators. Contents: methods of representing algorithms, Python language, data types, operations, I/O operators, programming of branched, iterative and nested cyclic algorithms, functions, strings, lists and tuples; dictionaries, numpy library, data collection, introduction to OOP in Python.																	
13	Computer modeling of engineering problems	Purpose: to master the methods and algorithms used in the development of computer models; to gain skills in working with applied software for computer	5											**v**	**v**				

		modeling of engineering tasks. Contents: modern software packages for solving engineering problems, basic arithmetic operations, the use of physical quantities, actions with complex numbers, entering and editing formulas in MathCAD, graphs of one and two variables, building wave, vector and potential diagrams, solving equations.																	
14	Discrete Math	Purpose: to master the basic concepts and methods of discrete mathematics by students: the theory of functions of the algebra of logic, elements of the theory of functions	5										**v**						

		of multivalued logic, elements of combinatorics, graph theory, mathematical logic: calculus of statements and predicates. Contents: the beginnings of (naive) set theory, elementary combinatorics, functions of the algebra of logic, elements of graph theory, predicate calculus, a review of formal arithmetic and axiomatic set theory.																
15	Ordinary differential equations	Purpose: formation of basic knowledge on the sections of the theory of ordinary differential equations (ODES), formulation of problems and	5													v			

		methods of solutions. Contents: ODE of the 1st order. The Cauchy problem. An ODE to higher orders. ODE systems. Linear odes with variable coefficients. Numerical integration of ODES and ODE systems. Using Matlab for numerical solution of ordinary differential equations.																	
16	Linear algebra and analytic geometry	Purpose: to provide basic knowledge on methods of solving algebraic equations and systems of linear equations, to familiarize with the methods of analytical geometry on the plane and in space.	5													V			

		Contents: determinants, algebraic equations: general theorems; polynomials; systems of equations and solution methods; matrices, matrix algebra; analytical geometry on the plane; analytical geometry in space.																	
17	Modeling in Matlab	Purpose: to develop the ability to use the Matlab system in solving applied problems and to teach students the ability to use it in order to simplify calculations and increase the speed of calculations. Contents: simple calculations, MatLab working environment, operations with	5												**v**				

		vectors and matrices, plotting in the MatLab system, M-files, programming in MatLab, function research, function integration, linear algebra problems, solving differential equations, the main features of the SIMULINK mathematical modeling package.																
18	Applied Mechanics	Purpose: to master the basics of scientific knowledge in the field of solid mechanics by students and develop skills for their application in practical work in their specialty. Contents: Force vector and its components. Systems of forces. Methods for	5										**v**		**v**			

		determining the movement of a point. The simplest motions of a rigid body. Plane motion of a rigid body. Complex point movement. Dynamics of a material point. Differential equations of motion of a material point. Dynamics of a system of material points. D'Alembert's principle for a material point.																	
19	Calculations in algebraic structures	Purpose: to obtain basic knowledge of basic algebraic structures; to instill the ability to carry out proofs of basic statements, establish logical connections between concepts, apply the	5								**v**								

		knowledge gained to solve problems related to applications of algebraic methods. Contents: commutative, associative distributive algebraic operations; definition of a group, rings; commutative ring, ring with one, properties of a ring, the concept of zero divisors, isomorphism of rings, residue ring, definition of a field, properties of a field.																	
20	Theory of the function of a complex variable	Purpose: to familiarize students with the theoretical foundations of the discipline; to create conditions for the formation of	5													**v**			

		logical and abstract thinking among students as the basis for their further effective learning. Contents: basic concepts of complex analysis, representation of functions by series, functional series, power series, Taylor series, Laurent series, singular points, deductions and their applications, Laplace transform, properties of Laplace transformations, some applications of operational calculus.																	
21	Algorithms and data structures	Purpose: to gain knowledge about the basic theoretical concepts underlying the process of	5						v	v									

		developing algorithms and data structures; to master the methods of developing and describing various algorithms related to data management. Contents: linear unidirectional list, linear lists with limited sets of operations, linear bidirectional list, trees, graphs, search in data structures, hashing, sorting problems (external and internal), algorithm development methods, combinatorial optimization problems.																
22	Probability theory	Purpose: to master the necessary mathematical apparatus, with the	5													**v**			

		help of which theoretical and experimental models of objects of professional activity are developed and studied. Contents: algebra of random events, combinatorics formulas, classical definition of probability, total probability formula, Bayes formulas, Bernoulli scheme, local and integral Laplace formulas, discrete random variables, continuous random variables, integral and differential distribution functions, mathematical expectation and dispersion, covariance and																	

		correlation, linear regression equations																	
23	Functional analysis	Purpose: to develop skills in analyzing functions in various spaces; to find the cardinality of a set, determine the norm and metric, orient in functional spaces, as well as prove theorems related to the studied topics. Contents: linear spaces equipped with metrics or norms, dual spaces, linear operators and their associated, self-adjoint operators in Hilbert spaces, elements of spectral theory, fixed point theorems and their applications.	5													**v**			

24	Math statistics	Purpose: to study the basic concepts of mathematical statistics, to master the patterns and methods of solving specific problems of mathematical statistics. Contents: General information about the selective method. Empirical distribution function. Average values. Indicators of variation. Statistical estimates of distribution parameters. Methods for finding point estimates. The concept of interval estimation. Testing statistical hypotheses. Criterion $\chi 2$ and its application to testing hypotheses	5													**v**			

		about the type of distribution.Testing hypotheses about the equality of the averages of two populations. Elements of correlation analysis. The correlation coefficient and its properties. Significance check and interval estimation of communication parameters. The correlation relation. Determination of parameters of nonlinear regression by the least squares method.																	
25	Geometric modeling in OpenGL	Purpose: to study the basics of geometric modeling, the principles of creating applied	5									**v**							

		software in the field of graphic information processing; students acquire knowledge of modern methods for solving computational geometry problems and processing graphical information. Contents: geometric models, OpenGL architecture and syntax features, visualization of primitives, image visualization in OpenGL, transformation and projection matrices in OpenGL, images of curves and surfaces.																
The cycle of basic disciplines Component of choice																			

26	3D modeling	Purpose: to master the 3ds MAX graphics editor, with which you can model three-dimensional images of objects, as well as basic concepts of animation programs and fundamental tools. Contents: types of models, three-dimensional workspace, three-dimensional modeling editor, types of projections in 3ds MAX, world and object coordinate system, creation of the simplest three-dimensional scene, creation of stereometry shapes, grouping of objects, management of drawing and	5 5									**v**							

		modification tools, materials and texturing, creation of simple models.																		
2 7	Fundamentals of sustainable development and ESG projects in Kazakhstan	Purpose: the goal is for students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to develop an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Contents: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study				**v**		**v**												

		of national and international standards, analysis of successful ESG projects and strategies for their implementation in enterprises and organizations.																	
8	2	Fundamentals of Artificial Intelligence	Purpose: to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. Contents: general definition of artificial intelligence, intelligent agents, information retrieval and state space exploration, logical agents, architecture of																

		artificial intelligence systems, expert systems, observational learning, statistical learning methods, probabilistic processing of linguistic information, semantic models, natural language processing systems.																	
29	Integral equations	The purpose of the course is to acquire knowledge and skills in classifying integral equations; mastering methods for solving them and developing the ability to independently use the acquired knowledge in their professional activities and the formation of appropriate										v							

		competencies. Contents: Volterra integral equations. Fredholm integral equations. The application of integral transformations to the solution of integral equations. Integral equations of the 1st kind. Approximate methods for solving integral equations.																	
30	Mathematical statistics and stohastic processes	Purpose: to form students' knowledge about the construction and analysis of mathematical models that take into account random factors, to give a modern understanding of the methods of stochastic mathematics used for analysis and														**v**			

		mathematical modeling. Contents: systems of random variables, random processes, Markov chains, Pearson and Kolmogorov agreement criteria, regression and correlation analysis, time series, queuing systems.																	
31	Introduction to financial mathematics	Purpose: to provide the future specialist with a certain amount of knowledge on certain sections of financial mathematics necessary for carrying out credit and a number of other commercial operations. Content: Simple percentages. Compound interest. Actions		v	v	v													

		with continuous percentages. The equivalence of interest rates. Rental payments and their analysis. Credit calculations. Changing calculation schemes under conditions of uncertainty. The classical scheme for evaluating financial transactions in conditions of uncertainty. Characteristics of probabilistic financial transactions: financial risks.																	
32	Legal regulation of intellectual property	Purpose: the goal is to form a holistic understanding of the system of legal regulation of intellectual property, including			**v**		**v**												

		basic principles, mechanisms for protecting intellectual property rights and features of their implementation. Content: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.																	
The cycle of core disciplines The university component																			
33	Partial differential equations	Purpose: to get acquainted with the classification of partial differential equations and their physical	6													**v**			

		interpretation, to study the formulations of boundary value problems for these equations and ways to solve the tasks set. Contents: classification of partial differential equations of the 2nd order, the theorem on reduction to the canonical form of a quasi-linear partial differential equation of the 2nd order, the theory of hyperbolic equations, the theory of elliptic equations, the theory of parabolic equations.																
34	Machine learning methods	Purpose: to teach students the theoretical and practical rules of machine learning, the skills of	6														v		v

		applying machine learning methods and models. Contents: structure of the field of machine learning, linear regression problems with one variable, gradient descent method, multidimensional linear regression, logistic regression, systematization methods, training of neural networks, machine learning experience, linear regression with regularization, unsupervised learning, dimensionality reduction, analysis of the main components, anomaly detection.																
35	Mathematical models in neural networks	Purpose: to master the theoretical and practical foundations of	5														v		v

		neural network models by students; to study the methods of designing and training neural networks; to build neural network mathematical models and analyze their functioning. Contents: the structure and properties of an artificial neuron, the basic concepts of artificial neural networks, artificial neural networks simulating the properties of natural neural networks, the use of artificial neural networks, the use of fuzzy and neural network models in applied tasks, the design of models of fuzzy and neural network technologies.																

36	Optimization and control	Purpose: students gain knowledge about modern methods of solving mathematical optimization problems; formation of optimization thinking; development of mathematical and algorithmic intuition in solving problems encountered in practice. Contents: problem statement and data analysis, linear programming, simplex method, dual problem, mathematical model of the transport problem, methods of constructing an optimal plan, method of potentials, networks, integer programming, binary programming,	5														v			

		elements of game theory, nonlinear optimization, gradient descent.																	
37	Applied Analysis	Purpose: to teach students to choose the most effective ways to solve problems using numerical methods used in practice, and to compile its algorithms. Contents: error analysis, iteration method for a fixed point, methods for solving nonlinear equations and systems of equations, Raphson-Newton method, Jacobi and Gauss-Seidel methods, interpolation, least squares method, interpolation with splines, numerical differentiation, numerical	6												**v**				

		integration, Cauchy problem for ordinary differential equations, boundary value problem, run-through method.																	
38	Artificial intelligence	Purpose: to form systematic knowledge about modern computer science methods; to expand and deepen the concepts of artificial intelligence; to develop abstract thinking, spatial representations, computational, algorithmic cultures and general mathematical and information culture.. Contents: the main directions of research in the field of artificial	4															**V**		

		intelligence (AI), genetic algorithms, instrumental computer tools for the development of AI systems, the basics of the theory of knowledge representation, the basics of the theory of neural and random networks, the concept of an expert system, the task of pattern recognition.																	
39	Numerical methods and programming	Purpose: to study the basic techniques of developing and applying in practice methods for solving various mathematical problems arising both in theory and in applications to various fields of mathematics, physics, mechanics,	6						**v**						**v**				

		chemistry, etc. Contents: computational error; concepts of approximation, stability, convergence of the algorithm; methods of localization of roots; iterative methods of solving a system of linear algebraic equations interpolation; numerical differentiation, integration; numerical methods for solving the Cauchy problem for ODE.																	
40	Mathematical and computer modeling of chemical-technological and physical processes	Purpose: to form students' theoretical knowledge, practical skills and abilities in the application of modern methods of mathematical and	6											**v**	**v**	**v**			

		computer modeling of chemical, technological and physical processes. Contents: general principles of modeling, deterministic mathematical models of chemical technological processes, experimental statistical methods for constructing mathematical models, basic methods for finding patterns and relationships between the studied objects, the use of universal software packages and analytical platforms for data analysis.																
The cycle of core disciplines Component of choice																			

41	Optimization methods	Purpose: to study the basics of the theory of mathematical methods for finding optimal solutions in problems of mathematical programming, calculus of variations and optimal control. Contents: linear programming problem, canonical type of linear programming problem, graphical solution under given constraints, dual problem, simplex method, transport problem, minimum element method, potential method, Pareto set, methods for finding optimal solutions under uncertainty,	5													**v**			

		methods for solving problems in game theory.																	
42	Asymptotic expansions and averaging	Purpose: to introduce the main types of asymptotic methods used in solving low-parametric algebraic and ordinary differential equations. Contents: dimension analysis, calibration functions, asymptotic sequences and series, solution of algebraic equations, application of asymptotic classification to the calculation of integrals, self-moving oscillatory systems, weakly nonlinear															v		

		oscillatory systems of general form, 2nd-order differential equations with a small parameter by a higher-order derivative.																	
43	Advanced machine learning algorithms	Purpose: to familiarize with modern approaches to the construction, training and use of recognition and classification systems based on machine learning methods and deep learning neural networks. Contents: adaptive linear neurons, training models based on decision trees, algorithms for sequential feature selection, data compression using dimensionality	5														**v**		**v**

		reduction, implementation of a multilayer artificial neural network, deep convolutional neural networks, recurrent neural networks.																	
44	Elements of Data Science	Objective: to form students' holistic understanding of the problems arising in the field of working with data and their solution, taking into account various conditions. Content: data processing tasks, end-to-end Big Data technologies, quantitative and qualitative data processing methods, intelligent data processing methods, Data Mining tasks,															**v**		**v**

		fuzzy data, text, image, sound analysis technologies; big data processing technologies, technology for obtaining, presenting and processing knowledge.																	
45	Mathematics of cryptography	Purpose: to study the mathematical foundations of cryptography, to teach the student information security methods and their use in the field of information security. Contents: cryptology, cryptography, cryptanalysis, encryption, durability, security, imitability, authenticity, modern	5									**v**					**v**		

		cryptographic methods of information protection, encryption, mathematical foundations of algorithms of asymmetric cryptosystems, mathematical foundations of algorithms of symmetric cryptosystems, methods research of cryptographic algorithms, models of encryption systems, mathematical foundations of electronic digital signature algorithms, cryptographic key management, steganography.																	
46	Encryption algorithms and	The purpose of mastering the discipline is to														**v**			**v**	

	computer security tools	study modern concepts of computer security, application in ensuring the protection of information, the safe use of software in computing systems. To teach the student the methods of information security, their use in the field of information protection. The objective of the course is to present the theory of information security, the practice of applying cryptographic algorithms.																		

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	**B057 - "Information technologies"**
Educational program	**6B06103 - "Mathematical and computer modeling"**
The awarded academic degree	**Bachelor of information and communications technologies**
Form and duration of study	**full time - 4 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		4 course		
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem	7 sem	8 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)																	
M-1.Module of language training																	
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E	5								
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E	5								
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E		5							
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E		5							
M-2.Module of physical training																	
KFK101	Physical culture I		GED, RC	2	60	0/0/30	30	E	2								
KFK102	Physical culture II		GED, RC	2	60	0/0/30	30	E		2							

KFK103	Physical culture III		GED, RC	2	60	0/0/30	30	E			2						
KFK104	Physical culture IV		GED, RC	2	60	0/0/30	30	E				2					
M-3. Module of information technology																	
CSE677	Information and communication technology		GED, RC	5	150	30/15/0	105	E				5					
M-4. Module of socio-cultural development																	
HUM137	History of Kazakhstan		GED, RC	5	150	15/0/30	105	GE	5								
HUM132	Philosophy		GED, RC	5	150	15/0/30	105	E			5						
HUM120	Module of socio-political knowledge (sociology, political science)		GED, RC	3	90	15/0/15	60	E			3						
HUM134	Module of socio-political knowledge (cultural studies, psychology)		GED, RC	5	150	30/0/15	105	E				5					
M-5. Module of anti-corruption culture, ecology and life safety base																	
HUM136	Fundamentals of anti-corruption culture and law	1	GED, CCH	5	150	30/0/15	105	E			5						
MNG489	Fundamentals of economics and entrepreneurship	1	GED, CCH	5	150	30/0/15	105	E			5						
ELC577	Fundamentals of scientific research methods	1	GED, CCH	5	150	30/0/15	105	E			5						
MNG564	Basics of Financial Literacy	1	GED, CCH	5	150	30/0/15	105	E			5						
CHE656	Ecology and life safety	1	GED, CC	5	150	30/0/15	105	E			5						

			H														
CYCLE OF BASIC DISCIPLINES (BD)																	
M-6.Module of physical and mathematical training																	
MAT169	Mathematical Analysis I		BD, UC	5	150	15/0/30	105	E	5								
PHY111	Physics I		BD, UC	5	150	15/15/15	105	E	5								
MAT170	Mathematical Analysis II		BD, UC	5	150	15/0/30	105	E		5							MAT169
PHY112	Physics II		BD, UC	5	150	15/15/15	105	E		5							PHY111
MAT171	Mathematical Analysis III		BD, UC	5	150	15/0/30	105	E			5						MAT170
MAT416	Mathematical analysis IV		BD, UC	6	180	30/0/30	120	E				6					MAT171
M-7. Module of basic training																	
MAT444	Algorithmization and programming in Python		BD, UC	4	120	15/0/30	75	E	4								
MAT178	Discrete Math		BD, UC	5	150	15/0/30	105	E		5							
AAP173	Practical training		BD, UC	2				R		2							
MAT189	Linear algebra and analytic geometry		BD, UC	5	150	15/0/30	105	E			5						
MAT455	3D modeling	1	BD, CCH	5	150	15/0/30	105	E			5						
MNG563	Fundamentals of sustainable development and ESG projects in Kazakhstan	1	BD, CCH	5	150	30/0/15	105	E			5						
CSE831	Fundamentals of Artificial Intelligence	1	BD, CC	5	150	15/0/30	105	E			5						

			H														
MAT445	Computer modeling of engineering problems		BD, UC	5	150	15/0/30	105	E				5					
MAT110	Ordinary differential equations		BD, UC	5	150	15/0/30	105	E				5					MAT170
PHY107	Applied mechanics		BD, UC	5	150	30/0/15	105	E					5				PHY111, MAT101
MAT449	Calculations in algebraic structures		BD, UC	5	150	15/0/30	105	E					5				
MAT181	Theory of functions of a complex variable		BD, UC	5	150	15/0/30	105	E					5				MAT172
MAT450	Algorithms and data structures		BD, UC	5	150	15/0/30	105	E					5				
MAT166	Probability theory		BD, UC	5	150	15/0/30	105	E					5				
MAT465	Modeling in Matlab		BD, UC	5	150	15/0/30	105	E					5				MAT110, MAT189, MAT445
MAT403	Functional analysis		BD, UC	5	150	15/0/30	105	E						5			MAT172
MAT167	Math statistics		BD, UC	5	150	15/0/30	105	E						5			MAT166
MAT451	Geometric Modeling in OpenGL		BD, UC	5	150	15/0/30	105	E							5		
MAT466	Integral equations	1	BD, CCH	5	150	15/0/30	105	E							5		MAT416
MAT198	Introduction to financial mathematics	1	BD, CCH	5	150	15/0/30	105	E							5		MAT103
MNG562	Legal regulation of intellectual property	1	BD, CCH	5	150	30/0/15	105	E							5		

MAT414	Applied Logic	1	BD, CCH	5	150	15/0/30	105	E						5		MAT171
MAT410	Mathematical statistics and stohastic processes	1	BD, CCH	5	150	15/0/30	105	E						5		
CYCLE OF PROFILE DISCIPLINES (PD)																	
M-7. Module of basic training																	
AAP102	Production practice I		PD, UC	2				R				2					
M-8. Module of professional activity																	
MAT447	Partial differential equations		PD, UC	6	180	30/0/30	135	E					6				
MAT467	Numerical methods and programming		PD, UC	6	180	30/0/30	120	E					6			MAT110, MAT189, MAT416	
AAP183	Production practice II		PD, UC	3				R					3				

MAT457	Optimization methods	1	PD, CCH	5	150	15/0/30	105	E						5			
MAT195	Asymptotic expansions and averaging	1	PD, CCH	5	150	15/0/30	105	E						5			
MAT454	Mathematical and computer modeling of chemical-technological and physical processes Item Description		PD, UC	6	180	30/0/30	120	E							6		
MAT421	Machine learning methods		PD, UC	6	180	30/0/30	120	E							6		
MAT179	Optimization and control		PD, UC	5	150	15/0/30	105	E							5		MAT172
MAT461	Artificial intelligence		PD, UC	4	120	15/0/30	75	E							4		
MAT452	Mathematical models in neural networks		PD, UC	5	150	15/0/30	105	E								5	
MAT419	Applied analysis		PD, UC	6	180	30/0/30	120	E								6	
MAT156	Advanced machine learning algorithms	1	PD, CCH	5	150	15/0/30	105	E								5	
MAT459	Elements of Data Science	1	PD, CCH	5	150	15/0/30	105	E								5	
SEC199	Mathematics of cryptography	2	PD, CCH	5	150	30/0/15	105	E								5	
MAT460	Encryption algorithms and computer security tools	2	PD, CCH	5	150	15/0/30	105	E								5	
M-9.Module of final attestation																	
ECA103	Final examination		FA	8												8	
Additional type of training (ATT)																	
AAP500	Military training																
Total based on UNIVERSITY:									31	29	30	30	30	30	31	29	
									60		**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	51	0	5	56
BD	Cycle of basic disciplines	0	102	10	112
PD	Cycle of profile disciplines	0	49	15	64
Total for theoretical training:		**51**	**151**	**30**	**232**
FA	Final attestation				8
TOTAL:					**240**

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. B.
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	Chimbayev Y. T.
Department Chair - Higher Mathematics and Modeling	Tuleshova G. .
Representative of the Academic Committee from Employers ___Acknowledged___	Verbovsky V. V.