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 2024

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. 12 of 22.04.2024 year.

Was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council
Protocol No. 6 of 19.04.2024 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:				
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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 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.

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. LO2: Demonstrate skills in managing research and production activities 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 of research methodologies, communicative and universal principles of life and models of project management and human resources; be able to analyze technical documentation, extract from it the information necessary to solve the task. LO4: to defend and prove one's own assessment of the latest domestic or foreign experience in forming an original judgment on a professional problem and conducting 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, the 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 algorithms and ways to represent them, the 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 skills in developing console applications in the style of object-oriented programming, programming numerical methods for solving linear algebra problems, differential equations, nonlinear equations and systems 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: Be able to apply the basic methods of set theory, group theory, and polynomial algebra in solving problems in related fields of mathematics; have theoretical knowledge in the field of researching properties and developing methods for solving extreme problems; demonstrate the ability and willingness to acquire skills in solving typical problems of calculus of variations and optimal control. LO9: to know the ways of defining curves, surfaces, three-dimensional geometric objects, the main 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; to 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: Have knowledge of the fundamentals of fundamental disciplines of mathematics and physics. Know the basic mathematical and physical theories and be able to apply them to specific tasks. To know the basics of information technology and modern software tools for engineering analysis, the principles of building computer models. Be able to apply the basic concepts and laws of mechanics; the methods resulting from these laws for studying the equilibrium and motion of a material point, solid body and mechanical system in their 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. 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 the formation of the ability to solve problems of professional activity: methods of linear algebra, analytical geometry, differential calculus of functions of one and many variables, integral calculus of functions of one and many variables, methods for solving differential equations, methods of probability theory and basic methods of mathematical statistics, optimization methods, discrete, integer, nonlinear, linear programming, methods for 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 artificial intelligence tools; 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 tasks 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)															
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12	LO13	LO14	LO15	LO16
The cycle of general education disciplines Required component																			
1	Foreign language	English is a discipline of the general education cycle. After determining the level (according to the results of diagnostic testing or IELTS results), students are divided into groups and disciplines. The name of the discipline corresponds to the level of English proficiency. During the transition from level to level, the prerequisites and post-prerequisites of discipline are observed.	10			v	v												

2	Kazakh (Russian) language	The socio- political, socio-cultural spheres of communication and functional styles of the modern Kazakh (Russian) language are considered. The course highlights the specifics of the scientific style in order to develop and activate students' professional and communication skills. The course allows students to practically master the basics of scientific style and develops the ability to perform structural and semantic analysis of the text.	10			√	√													
3	Physical Culture	The purpose of the discipline is the practical use of skills in performing the basic elements of athletics techniques, sports games, gymnastics and a set of standards for general physical training, including professionally applied physical training or one of the sports, methods of conducting independent physical exercises.	8			√	√													

4	Information and communication technologies (MOOC)	The task of studying the discipline is to acquire theoretical knowledge about information processes, about new information technologies, local and global computer networks, information security methods; to gain skills in using text editors and tabular processors; to create databases and various categories of application programs.	5			v	v													
5	The history of Kazakhstan	The course studies historical events, phenomena, facts, processes that took place on the territory of Kazakhstan from ancient times to the present day. The sections of the discipline include: introduction to the history of Kazakhstan; the steppe empire of the Turks; early feudal states on the territory of Kazakhstan; Kazakhstan during the Mongol conquest (XIII century); medieval states in the XIV-XV centuries. The main stages of the formation of the Kazakh statehood are also considered: the era of the Kazakh Khanate of the XV-XVIII centuries. Kazakhstan is part of the Russian Empire; Kazakhstan during the period of civil confrontation and under the conditions of a totalitarian system; Kazakhstan during the Great Patriotic War The Great Patriotic War; Kazakhstan during the period of independence and at the present stage.	5				v													

6	Philosophy (MOOC)	Philosophy forms and develops critical and creative thinking, worldview and culture, provides knowledge about the most general and fundamental problems of existence and gives them a methodology for solving various theoretical and practical issues. Philosophy expands the horizon of vision of the modern world, forms citizenship and patriotism, promotes self-esteem, awareness of the value of human existence. It teaches you to think and act correctly, develops practical and cognitive skills, helps you search and find ways and means of living in harmony with yourself, society, and the world around you.	5			v	v													
7	Module of socio-political knowledge (sociology, political science) (MOOC)	The discipline is designed to improve the quality of both general humanitarian and professional training of students. Knowledge in the field of sociology and political science is the key to effective professional activity of a future specialist, as well as for understanding political processes, for the formation of political culture, developing a personal position and a clearer understanding of the measure of their responsibility.	3	v	v															
8	Module of socio-political knowledge (cultural studies and psychology) (MOOC)	The module of socio-political knowledge (cultural studies, psychology) is designed to familiarize students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal patterns of formation and development of	5	v	v															

		culture, to develop their aspirations and skills of independent comprehension of the wealth of values of world culture for self-improvement and professional growth. During the course of cultural studies, the student will consider the general problems of the theory of culture, the leading cultural concepts, universal patterns and mechanisms of formation and development of culture, the main historical stages of the formation and development of Kazakh culture, its most important achievements. During the course, students acquire theoretical knowledge, practical skills and abilities, forming their professional orientation from the perspective of psychological aspects.																		
The cycle of general education disciplines **Component of choice**																				
9	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. Content: improvement of socio-economic relations of the Kazakh society, psychological features of corrupt behavior, formation of an anti-corruption culture, legal responsibility for acts of corruption in various fields.	5	**v**	**v**															

10	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 problems, issues of search, accumulation and processing of scientific information.	5			v	v													
11	Fundamentals of financial literacy	Purpose: formation of financial literacy of students on the basis of building a direct link between the acquired knowledge and its practical application. Content: 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 and paying taxes and correctly filling out tax reports, analyzing financial information and orienting in financial products to choose an adequate investment strategy.		v	v															
12	Fundamentals of Economics and entrepreneurship	Purpose: to study the basics of economics and entrepreneurship from the point of view of science and law, to master the conceptual	5	v	v															

		apparatus and the basic forms of doing business. Contents: the concept of entrepreneurship – definition, types, trends of development, the role of entrepreneurship; basic concepts of market economy, organizational foundations of business, financial foundations of business, development of a business development strategy, state regulation of entrepreneurial activity.																		
13	Ecology and life safety	Purpose: formation of ecological knowledge and 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.	5		v			v												
The cycle of basic disciplines The university component																				
14	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	5														v			

		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 differential; derivatives and differentials of higher order; conditions of stability and monotony; largest and smallest values; a complete study of the function using derivative, plotting.																		
15	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; primitive and indefinite integral of a function of one variable; method of integration in parts; integration of rational fractions, irrational functions, trigonometric functions; definite integral; improper integrals; application of a definite integral in geometry and physics; calculation of the area of a flat figure; calculation of the volume of an arc of a curve on a plane, a body of rotation; numerical calculation methods a definite integral.	5														**v**			
16	Mathematical Analysis III	Purpose: to provide basic knowledge on the differential and integral calculus of the function of many variables. Contents: Differential and integral calculus of the function of many variables. Curvilinear, double and multiple integrals; surface and volume integrals; mean value theorems;	5														**v**			

		Fourier series and integrals. Applications of differential and integral calculus of functions of many variables in mechanics and engineering.																		
17	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, closed—loop integrals, calculation of a double integral, Green's formula, surface integrals, Stokes formula and its application, triple and multiple integrals, Gauss-Ostrogradsky formula, elements of vector analysis.	6													v			
18	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 of the specialty. Contents: mechanics, dynamics of rotational motion of a solid, mechanical harmonic waves, fundamentals of molecular kinetic theory and thermodynamics, transport phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell equations.	5											v					

19	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 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.	5												v					
20	Algorithmization and programming in Python	Purpose: to develop students' skills to formulate the principles of creating programs and methods of their implementation in Python using algorithms, data structures and operators. Content: 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 SEN in Python.	4						v	v										
21	Computer modeling of engineering tasks	Purpose: to master the methods and algorithms used in the development of computer models; to gain skills in working with applied software for computer modeling of engineering tasks.	5											v	v					

		Contents: modern software packages for solving engineering problems, basic arithmetic operations, the use of physical quantities, operations with complex numbers, entering and editing formulas in MathCAD, graphs of one and two variables, building wave, vector and potential diagrams, solving equations.																		
22	Ordinary differential equations	Purpose: formation of basic knowledge on the sections of the theory of ordinary differential equations (ODES), formulation of problems and methods of solutions. Content: An 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.	5														**v**			
23	Linear algebra and analytical 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. Contents: determinants, algebraic equations: general theorems; polynomials; systems of equations and methods of solution; matrices, algebra of matrices; analytical geometry on a plane; analytical geometry in space.	5														**v**			

24	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 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.	5												**V**				
25	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: The force vector and its components. Systems of forces. Ways to set the movement of a point. The simplest movements of a solid body. Flat motion of a solid body. Complex point movement. The dynamics of a material point. Differential equations of motion of a material point. Dynamics of the system of material points. The Dalembert principle for a material point.	5											**V**		**V**			

26	Discrete mathematics	Purpose: to master the basic concepts and methods of discrete mathematics: the theory of functions of algebra of logic, elements of the theory of functions of multivalued logic, elements of combinatorics and graph theory; and 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, review of formal arithmetic and axiomatic set theory.	5										**v**						
27	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 knowledge gained to solve problems related to applications of algebraic methods. Contents: commutative, associative distributive algebraic operations; definition of a group, definition of a ring, commutative ring and a ring with one, properties of a ring, the concept of zero divisors, isomorphism of rings, ring of residues, definition of a field, properties of a field.	5								**v**								

28	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 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.	5														**v**			
29	Algorithms and data structures	Purpose: to gain knowledge about the basic theoretical concepts underlying the process of 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.	5						**v**	**v**										
30	Probability theory	Purpose: to master the necessary mathematical apparatus, with the help of which theoretical and experimental models	5														**v**			

		of objects of professional activity are developed and studied. Contents: algebra of random events, combinatorics formulas, classical definition of probability, full probability formula, Bayes formulas, Bernoulli scheme, local and integral Laplace formulas, discrete random variables, continuous random variables, integral and differential distribution functions, expectation and variance, covariance and correlation, linear regression equations.																		
31	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, conjugate spaces, linear operators and their attached, self-adjoint operators in Hilbert spaces, elements of spectral theory, fixed point theorems and their applications.	5															v			
32	Geometric modeling in OpenGL	Purpose: to study the basics of geometric modeling, the principles of creating applied 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	5									v								

		and syntax features, visualization of primitives, image visualization in OpenGL, transformation and projection matrices in OpenGL, images of curves and surfaces.																	
33	Educational practice	The student's academic practice is conducted in order to study the latest theoretical, methodological and technological achievements of domestic and foreign science.	2	v	v	v	v	v	v										
The cycle of basic disciplines Component of choice																			
34	3D modeling	Objective: 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 modification tools, materials and texturing, creation of simple models.										v							
	Legal regulation of intellectual property	Objective: to form a holistic view of the system of legal regulation of intellectual property, including the basic principles, mechanisms for the protection of intellectual property rights and the specifics of their implementation. Content: The	5		v		v												

	discipline covers the basics of IS law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, as well as consider legal disputes and how to resolve them.																	
Fundamentals of sustainable development and ESG projects in Kazakhstan	Objective: students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to form an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Content: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study of national and international standards, analysis of successful ESG projects and strategies for their implementation at enterprises and organizations.																	
The basics 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.																		
35	Calculus of variations and optimal control	Purpose: to study the basic principles of formulation and research of extreme problems of mathematical modeling and mathematical physics, as well as methods for solving typical problems of calculus of variations and optimal control. Contents: classical calculus of variations, integral calculus of variations, differentiation of maps, smooth problems with constraints in the form of equalities and inequalities, optimization in infinite-dimensional spaces, Pontryagin maximum principle, Bellman dynamic programming.	5							v										
	Mathematical statistics and stochastic 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 mathematical modeling. Contents: systems of random variables, random processes, Markov chains, Pearson and Kolmogorov agreement criteria, regression and correlation analysis, time series, queuing systems.												v						

	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, 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.					v						v				
	Applied Logic	Purpose: to develop an understanding of the logical structure of computer programs, to introduce specifications of responsive information systems into languages. Contents: logical programs, unification, unification algorithm; resolution method, conclusion; semantics: erbran interpretations, many program solutions, completeness of the resolution method; algorithmic properties of the smallest Erbran model; the problem of negation: lists, structures; language and semantics: temporal propositional calculus; correctness theorem; theorems on deduction, on substitution; language and semantics of temporal predicate logic.									v						

The cycle of core disciplines The university component																				
36	Partial differential equations	Purpose: to get acquainted with the classification of partial differential equations and their physical 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.	6														**v**			
37	Machine learning methods	Purpose: to teach students the theoretical and practical rules of machine learning, skills in applying machine learning methods and models. Contents: structure of the field of machine learning, tasks of linear regression 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.	6															**v**		**v**

38	Mathematical models in neural networks	Purpose: to master the theoretical and practical foundations of 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.	5														v		v
39	Optimization and management	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, elements of game theory, nonlinear optimization, gradient descent.	5														v			

40	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 integration, Cauchy problem for ordinary differential equations, boundary value problem, run-through method.	6												**v**				
41	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 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.	4														**v**		

42	Linear programming	Purpose: to form students' knowledge of the basic concepts, definitions and statements of linear programming, skills in applying this theory to solve practical problems. Teaching students to apply linear programming methods and models in the process of preparing and making managerial decisions. Contents: methods for solving linear programming problems, graphical method for solving LP problems, Simplex method, artificial basis method, duality in LP, transport problem, method of potentials.	6													v			
43	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 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.	6											v	v	v			
44	Production practice I	Purpose: to develop students' skills in building and researching mathematical models of various systems and processes; skills in mathematical description,	2	v	v	v	v	v	v										

		aggregation and decomposition of the studied systems; skills in setting practical tasks, self-study of mathematical models of systems and processes; skills in constructing and implementing algorithms for solving specific engineering and applied problems to obtain numerical results of model research with the required accuracy.																	
45	Industrial practice II	Purpose: to develop students' skills in building and researching mathematical models of various systems and processes; skills in mathematical description, aggregation and decomposition of the studied systems; skills in setting practical tasks, self-study of mathematical models of systems and processes; skills in constructing and implementing algorithms for solving specific engineering and applied problems to obtain numerical results of model research with required accuracy; gain practical experience of participating in the development of software requirements and in software design using specialized software packages.	3	v	v	v	v	v	v	v									
The cycle of core disciplines Component of choice																			
46	Optimization methods	Purpose: to study the basics of the theory of mathematical methods for finding optimal solutions in problems of mathematical	5													v			

		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, methods for solving problems in game theory.																		
	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 oscillatory systems of general form, 2nd-order differential equations with a small parameter by a higher-order derivative.															v			
47	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	5															v		v

		trees, algorithms for sequential feature selection, data compression using dimensionality reduction, implementation of a multilayer artificial neural network, deep convolutional neural networks, recurrent neural networks.																		
	Data Science Elements	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, fuzzy data, text, image, sound analysis technologies; big data processing technologies, technology for obtaining, presenting and processing knowledge.																v		v
48	The 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 cryptographic methods of information protection, encryption, mathematical foundations of algorithms of asymmetric cryptosystems, mathematical foundations of algorithms of	5									v						v		

		symmetric cryptosystems, research methods of cryptographic algorithms, models of encryption systems, mathematical foundations of algorithms of electronic digital signature, cryptographic key management, steganography.																		
	Encryption algorithms and computer security tools	Purpose: to study modern concepts of computer security and their application in ensuring the protection of information and the safe use of software in computer systems. Content: tasks of protecting computer information, methods of encryption with a private key, cryptographic algorithms with a public key, electronic digital signature, use of hash functions, types of asymmetric digital signature algorithms, electronic signature based on the RSA algorithm, digital signature based on the El Gamal algorithm.																	**v**			**v**	

5. Curriculum of educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of KazRNTU named after K.Satpayev
_____ Z.M. Baigarayev
"___" _____ 2024 y.

CURRICULUM
of Educational Program on enrollment for 2024-2025 academic year

Educational program 6B06103 - "Mathematical and computer modeling"
Group of educational programs B057 - "Information technologies"

Form of study: full-time Duration of study: 4 years Academic degree: Bachelor in Information and Communication Technology

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	classroom volume of lek/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters							
								I course		II course		III course		IV course	
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	7 semester	8 semester
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)															
M-1. Module of language training															
LNG 108	English language	GED, RC	5	150	0/0/3	105	E	5							
LNG 108	English language	GED, RC	5	150	0/0/3	105	E		5						
LNG 104	Kazakh (Russian) language	GED, RC	5	150	0/0/3	105	E	5							
LNG 104	Kazakh (Russian) language	GED, RC	5	150	0/0/3	105	E		5						
M-2. Module of physical training															
KFK 101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Diferedit	2	2	2	2				
M-3. Module of information technology															
CSE 677	Information and communication technologies	GED, RC	5	150	2/1/0	105	E			5					
M-4. Module of socio-cultural development															
HUM 137	History of Kazakhstan	GED, RC	5	150	1/0/2	105	SE	5							
HUM 132	Philosophy	GED, RC	5	150	1/0/2	105	E			5					
HUM 120	Socio-political knowledge module (sociology, politology)	GED, RC	3	90	1/0/1	60	E			3					
HUM 134	Socio-political knowledge module (culturology, psychology)		5	150	2/0/1	150	E				5				
M-5. Module of anti-corruption culture, ecology and life safety base															
HUM136	Fundamentals of anti-corruption culture	GED, CCH	5	150	2/0/1	150	E				5				
MNG 489	Fundamentals of economics and entrepreneurship														
ELC 577	Fundamentals of research methods														
MNG564	Basics of Financial Literacy														
CHE656	Ecology and life safety														
CYCLE OF BASIC DISCIPLINES (BD)															
M-6. Module of physical and mathematical training															
MAT169	Mathematical analysis I	BD, UC	5	150	1/0/2	105	E	5							
PHY111	Physics I	BD, UC	5	150	1/1/1	105	E	5							
MAT444	Algorithmization and programming in Python	BD, UC	4	120	1/0/2	75	E	4							
MAT 170	Mathematical analysis II	BD, UC	5	150	1/0/2	105	E		5						
PHY112	Physics II	BD, UC	5	150	1/1/1	105	E		5						
MAT171	Mathematical analysis III	BD, UC	5	150	1/0/2	105	E			5					
MAT416	Mathematical analysis IV	BD, UC	6	180	2/0/2	120	E				6				

M-7. Module of basic training																
MAT445	Computer modeling of engineering problems	BD, UC	5	150	1/0/2	105	E		5							
MAT110	Ordinary differential equations	BD, UC	5	150	1/0/2	105	E				5					
MAT189	Linear algebra and analytic geometry	BD, UC	5	150	1/0/2	105	E			5						
MAT176	Matlab	BD, UC	5	150	1/0/2	105	E					5				
PHY107	Applied mechanics	BD, UC	5	150	2/0/1	105	E					5				
MAT178	Discrete Math	BD, UC	5	150	1/0/2	105	E				5					
MAT449	Calculations in algebraic structures	BD, UC	5	150	1/0/2	105	E					5				
MAT181	Theory of functions of a complex variable	BD, UC	5	150	1/0/2	105	E					5				
MAT450	Algorithms and data structures	BD, UC	5	150	1/0/2	105	E					5				
MAT166	Probability theory	BD, UC	5	150	1/0/2	105	E					5				
MAT403	Functional analysis	BD, UC	5	150	1/0/2	105	E						5			
MAT167	Math statistics	BD, UC	5	150	1/0/2	105	E						5			
MAT451	Geometric modeling in OpenGL	BD, UC	5	150	1/0/2	105	E							5		
MAT455	3D modeling	BD/CCH	5	150	1/0/2	105	E			5						
MNG563	Fundamentals of sustainable development and ESG projects in Kazakhstan				2/0/1											
CSE831	Fundamentals of Artificial Intelligence				1/0/2											
MAT193	Calculus of variations and optimal control	BD\CCH	5	150	1/0/2	105	E							5		
MAT248	Mathematical statistics and stochastic processes															
MAT456	Numerical methods and programming															
MAT414	Applied Logic															
MNG562	Legal regulation of intellectual property				2/0/1											
AAP173	Educational practice	BD, UC	2						2							
CYCLE OF PROFILE DISCIPLINES (PD)																
M-8. Module of professional activity																
MAT447	Partial differential equations	PD, UC	6	180	2/0/2	120	3							6		
MAT 421	Machine learning methods	PD, UC	6	180	2/0/2	120	3							6		
MAT452	Mathematical models in neural networks	PD, UC	5	150	1/0/2	105	3								5	
MAT179	Optimization and control	PD, UC	5	150	1/0/2	105	3							5		
MAT419	Applied analysis	PD, UC	6	180	2/0/2	120	3								6	
MAT461	Artificial intelligence	PD, UC	4	120	1/0/2	75	3							4		
MAT453	Linear programming	PD, UC	6	180	2/0/2	120	3						6			
MAT454	Mathematical and computer modeling of chemical-technological and physical processes	PD, UC	6	180	2/0/2	120	3						6			
MAT457	Optimization methods	PD, CCH	5	150	1/0/2	105	3									
MAT195	Asymptotic expansions and averaging												5			
MAT156	Advanced machine learning algorithms	PD, CCH	5	150	1/0/2	105	3								5	
MAT459	Elements of Data Science															
SEC199	Mathematics of cryptography	PD, CCH	5	150	2/0/1	105	3									
MAT460	Encryption algorithms and computer security tools				1/0/2										5	
AAP102	Production practice I	PD, UC	2								2					
AAP183	Production practice II	PD, UC	3										3			
M-9. Module of final attestation																
ECA109	Writing and defending a thesis (project)	FA	8													
M-10. Module of additional types of training																
AAP500	Military affairs	ATT	0													8
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		5	56
BD	Cycle of basic disciplines		102	10	176
PD	Cycle of profile disciplines		49	15	
	Total for theoretical training:				*232*
FA	Final attestation	8			8
	TOTAL:	8	0	0	240

Decision of the Academic **Council of Kaznu named after** K.Satpayev. **Protocol №** 12 22.04 **2024 y.**

Decision of the Educational **and Methodological Council of** Kaznu **named after K.Satpayev. Protocol** 6 19.04 **2024 y.**

Decision of the Academic Council of the Institute AIT **.** Protocol № 8 от "29" 02 2024 **y.**

Vice-Rector for Academic Affairs — Uskenbayeva R.

Institute Director — Kalpeyeva Z.

Department Head — Tulesheva G.

Specialty Council representative from employers — Ualiev Z.