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

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

EDUCATIONAL PROGRAM

8D06104 - Cybernetics and artificial intelligence

Code and Classification of Education Area:
8D06 Information and Communication Technology
Code and classification of areas of training:
8D061 Information and Communication Technologies
Group of educational programs:
D094 Information Technology

Level based on NQF: 8
Level based on IQF: 8
Study period: 3 years
Amount of credits: 180

Almaty, 2025

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

Educational program 8D06104 «Cybernetics and artificial intelligence» approved at the meeting of the Academic Council of KazNRTU named after K.I. Satpayev.
Protocol No.10 of "06" March 2025 year.

Considered and recommended for approval at the meeting of the Educational-Methodical Council of KazNRTU named after K.I. Satpayev.
Protocol No. 3 of "20" December 2024 year.

Educational program 8D06104 «Cybernetics and artificial intelligence» developed by the academic committee for the direction 8D061 "Information and communication technologies".

Name and surname.	Degree Academic title	Position	Place of work	Sign
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List of abbreviations and designations

EP - educational program,
LO - learning outcomes,
DG - Digital modeling,
IEP - individual educational plan

1. SHORT DESCRIPTION OF THE PROGRAM

The educational program belongs to engineering specialization.

It is aimed at providing basis and professional courses with due competence to students.

The tasks and content of the program are described in Section 7 of the document: «Description of the courses».

The specialization 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.

Students will study the main methods of artificial intelligence on simple handy problems and get the mathematical foundation of machine learning and artificial intelligence. The main idea of this program consists in modelling the intellectual activity by means of computers. Completing the program, students will have the knowledge of working machine learning algorithms and will be able to implement these skills in solution of various (theoretical or applied) problems. After successful completion of the program the students will be graduated the «bachelor» degree.

The education process presumes an active research work, participation in research projects supervised by leading specialists in priority scientific areas, and internship in foreign high-profile scientific and educational institutions. Some classes will get lectures by invited professors from Germany, France, Slovenia, etc.

For students to acquire competitive skills, the program includes innovative courses that cover all necessary areas from Mathematics, Data Science, Data Engineering and Quantitative Analysis (in Python and R languages).

2. The purposes of the curriculum program

The curriculum programme involves issues about fundamentals of the artificial intelligence system, features of its organization, functionality, life cycles and directions. Moreover, the programme helps to students to develop their competences in the project processes and professional activity in the contemporary intellectual systems.

Therefore, the curriculum programme focuses on the preparation of highly qualified specialists, who is capable to develop both computer and mathematical models for different applications according on the development of digital economy. The program has a practice-oriented base using the modern laboratory "Sigma LABS" at the School of mathematics and cybernetics.

Nowadays, the artificial intelligence modelling has two main approaches:

1. Machine intelligence, based on the strong task of the result of functioning;
2. Artificial intelligence, focusing on the modeling of the internal structure of the system.

The approaches division relates with the existence of two points of view on the question of how to build artificial intelligence systems.

The one side represents, that the most important fact is the result. It means, that the main idea focuses on the concurrence of artificial and natural intelligent systems, but not on the process of formulation of behavior through the internal mechanisms.

Another point of view is the consideration that the basis of the construction of artificial intelligence involves mechanisms of natural thinking and the analysis of data, which characterize the rational human behavior. Thus, this process is realized by the modeling using the technical principles and the specifics of the functionality of biological objects.

Therefore, the first direction studies the product of human intellectual activity and its structure, and focuses on the realization of the product through the instruments of modern technics. That modelling of the machine intelligence systems is achieved by using the laws of formal logic, set theory, graphs, semantic networks, and other scientific advances in the field of discrete computing. The main results are in the creation of expert systems, natural language parsing systems and the simplest control systems of the <stimulus-reaction> form. Therefore, the success of the first direction of the artificial intelligence is closely related with the development of computer capabilities and programming. So that, it involves the complex of scientific and technical research as computer sciences.

The second direction of artificial intelligence considers data of the neurophysiological and psychological mechanisms of intellectual activity, generally, as a rational human behavior. The direction represents mechanisms through the various technical devices, in case that the "behavior" of such devices concurs with a human behavior according to the certain limits. The development of this area is closely related to the studying of human sciences. It includes wider spectrum of rational human activity comparing with the machine intelligence. The artificial intelligence systems are based on the mathematical interpretation of the activity of the human brain nervous system. Thus, they are realized as neural networks, based neural element as an analog of a neuron.

3. Objectives of the educational program:

The app consists of 8 obligatory items in English/Kazakh/Russian languages. It is a standardized text that confirms that the application is compliant with European standards. The form of the European diploma application is shown in Annex A.

Section 1 Information about the qualification holder: the name, name (as recorded in the passport), date and place of birth,

identification number or student code are specified.

Section 2 Information on the qualification received: qualification name, major specialty, additional minor specialty (if available), name and status of a higher education institution, which assigned qualifications in the native language, the name and status of a higher education institution, the qualification in English, the language of instruction and control of knowledge.

Section 3 Information on the level of qualification: indicates the level of qualification - bachelor's degree (master's degree, doctorate), duration of study, requirements for admission.

Section 4 Information on the content of the training and the results: the form of education is specified - full, remote, abbreviated full, the requirement of the program (the required volume for the mastery of the program), the content of the educational program (mandatory and elective disciplines, student coursework, completed practices, protected diploma work indicating the laboriousness of disciplines, practices, coursework and diplomas, status (mandatory, by choice, additional), final assessments) in loans of RK and ECTS, national assessment scale approved by the order of MONRC and its description, the mechanism of transfer of assessments to the European system, general classification of qualifications.

Section 5 Professional qualifications: whether the qualifications are available to advance to the next stage of education and what requirements to do so must be met, professional status (which professional rights are acquired by students with qualifications).

Section 6 Additional information: additional information about the university, additional sources of information.

Section 7 App Certification: specified the date of qualification, the date of issuance, the name, the name of the official certifying the application to the diploma, signing the diploma itself; all of this information is sealed.

Section 8 Information on the National Higher Education System.

This application is issued only at the end of the university on the application of the graduate on a remunerative basis in accordance with the standards set by the university.

To receive the application, you must submit a written (electronic) application to the university office with an application copy of the receipt.

The application is issued by the Office registrar within 15 business days of application and is registered in the journal of issuance and registration of diplomas and applications. Application form forms are stored in the Registrar's Office.

3. Requirements for learning outcomes of the educational program

List of competencies

The PhD dissertation defense is confirmed in the closing stages of the PhD programme.

The defense of the PhD dissertation is controlled by the by the Dissertation Council at the university or, by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan.

Those, who has completed the whole curriculum programme will receive the PhD degree.

PhD persons should perform the post-doctoral program or conduct the scientific research under the guidance of a leading scientist for deeper learning of scientific and applied problems.

a. Requirements to the key competencies of the graduates:

have an idea about:

i. the key milestones of development and paradigm change of the science evolution;
ii. the knowledge domain, worldview and methodological specifics of natural (socio-humanitarian and economic) sciences;
iii. scholarly traditions of the suitable area, and their theoretical and practical studies;
iv. scientific outlooks of the world and Kazakhstan science in terms of the suitable area;
v. adaptation of scientific studies into the practical activity;
vi. standards and rules of cooperation in the scientific commonwealth;
vii. pedagogical and science-based ethics;

know and understand:

viii. contemporary trends, directions and common factors of national science in terms of globalization and internalization;
ix. achievements of the world and Kazakhstan science in terms of the suitable area;
x. the social amenability to the science and education;
xi. the foreign language to the communications with the scientific commonwealth;

be able to:

xii. organize, plan and implement the research process;
xiii. analyze, evaluate and compare various theoretical concepts in the field of research and make decisions;
xiv. analyze and process information from various sources;

xv. conduct an independent scientific study, characterized by academic integrity, based on modern theories and methods of analysis;
xvi. generate own new scientific ideas
xvii. share the knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;
xviii. choose and effectively use modern research methodology;
xix. plan and predict the further professional development;

have skills of:

xx. critical analysis, evaluation and comparison of various scientific theories and ideas;
xxi. analytical and experimental research activities;
xxii. planning and forecasting research results;
xxiii. public speaking at international scientific forums, conferences and seminars;
xxiv. scientific writing and scientific communication;
xxv. planning, coordinating and implementing research processes;
xxvi. systematic understanding of the field of study and demonstration of the quality and effectiveness of selected scientific methods;
xxvii. participation in scientific events, fundamental scientific domestic and international projects;
xxviii. leadership and team management;
xxix. responsible and creative attitude to scientific and scientifically pedagogical activity;
xxx. conducting of the patent search and experience of the transferring scientific information using modern information and innovative technologies;
xxxi. protection of the intellectual property rights for scientific discoveries and studies;
xxxii. the free communication by the foreign language;

be competent:

xxxiii. in the field of scientific and educational activities in case of rapid updating and growth of information flows;
xxxiv. in carrying out of the theoretical and experimental research;
xxxv. in the formulation and solution of theoretical and applied problems in scientific research;
xxxvi. in the realization of the professional and comprehensive analysis of problems in the relevant field;
xxxvii. in matters of interpersonal communication and human resource management;
xxxviii. in matters of the university’s training of the specialists;

xxxix. in the examination of scientific projects and research;
xl. into ensuring of the permanently professional growth.

b. Requirements to the internship realization:

The internship is performed in order to develop the practical skills of the scientific work and professional activity.

The educational program involves:

1) academic internship;

2) work experience internship.

The first one is realized with the purpose of studying of the modern theoretical, methodological and technological achievements of domestic and foreign science.

The work experience internship is performed to transfer theoretical knowledge into practice for improvement the professional level of the students.

Competence at the end of training

B - Basic knowledge, skills and skills:

B1- to be able to analyze the current problemsof the modernhistory of Kazakhstan;

B2 - to know and apply in practice the basics of engineering professional Ethics

B3 - to know the modern and promising directions of information technology development and mathematical methods of optimization.

P - Professional competencies, including in accordance with the requirements of industry professional standards:

P1 - a wide range of theoretical and practical knowledge in the professional field;

P2 - the ability to organize, provide, design mathematical models and implement them with the help of artificial intelligence and information technology.

A - Human, social and ethical competences:

A1 - the ability to constantly learn, to focus; Be confident in uncertainty. Have a high level of spatial and logical thinking;

A2 - the ability to work in a team, to have organizational skills, to prioritize, to quickly learn new knowledge and skills, to apply them in practice;

A3 - to be results-oriented, to plan effectively and organize one's development;

A4 - the ability to freely use English as a means of business communication, a source of new knowledge in the field of

mathematical and computer modeling.

S - Special and management competencies:

S1 - self-management and control of work and training processes within the framework of the organization's strategy, policy and objectives, critical discussion of the problem, reasoning conclusions and competent operation of information;

S2 - the ability to motivate to solve certain problems, the ability to be responsible for the result of work at the level of a unit or enterprise;

S3 - the ability to demonstrate a set of work management skills, the ability to choose methods, techniques and evaluation criteria to obtain results, distribute and delegate authority, form teams, and make decisions during the production process.

Learning outcomes

Learning Strategy

Level 3 descriptors within the Comprehensive Framework of Qualifications of the European Higher Education Area (QF-EHEA) reflect learning outcomes that characterise the learner's ability to:

1) demonstrate a systematic understanding of the field of study, mastery of the skills and research methods used in this field of cybernetics and artificial intelligence, based on advanced knowledge of this field of cybernetics and artificial intelligence, when developing and (or) applying ideas in the context of research;

2) demonstrate the ability to conceive, design, implement and adapt a substantial research process with a scientific approach;

3) contribute with original research to expanding the boundaries of a scientific field that deserves publication at the national or international level;

4) critically analyze, evaluate, and synthesize new and complex ideas;

5) communicate their knowledge and achievements to colleagues, the scientific community, and the general public;

6) to promote, in academic and professional contexts, the technological, social or cultural development of society based on knowledge.

4. Passport of the educational program

4.1 General information

№	Field name	Note
1	Code and classification of the field of education	8D06 Information and Communication Technology
2	Code and classification of training areas	8D061 Information and Communication Technologies
3	Group of educational programs	D094 Information Technology
4	Name of educational program	8D06104 «Cybernetics and artificial intelligence»
5	Brief description of the educational program	The educational program belongs to engineering specialization. It is aimed at providing basis and professional courses with due competence to students. The tasks and content of the program are described in Section 7 of the document: «Description of the courses». The specialization 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. Students will study the main methods of artificial intelligence on simple handy problems and get the mathematical foundation of machine learning and artificial intelligence. The main idea of this program consists in modelling the intellectual activity by means of computers. Completing the program, students will have the

		knowledge of working machine learning algorithms and will be able to implement these skills in solution of various (theoretical or applied) problems. After successful completion of the program the students will be graduated the «bachelor» degree. The education process presumes an active research work, participation in research projects supervised by leading specialists in priority scientific areas, and internship in foreign high-profile scientific and educational institutions. Some classes will get lectures by invited professors from Germany, France, Slovenia, etc. For students to acquire competitive skills, the program includes innovative courses that cover all necessary areas from Mathematics, Data Science, Data Engineering and Quantitative Analysis (in Python and R languages).
6	Purpose of the EP	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. The curriculum programme involves issues about fundamentals of the artificial intelligence system, features of its organization, functionality, life cycles and directions. Moreover, the programme helps to students to develop their competences in the project processes and professional activity in the contemporary intellectual systems. Therefore, the curriculum programme focuses on the preparation of highly qualified specialists, who is capable to develop both computer and mathematical models for different applications according on the development of digital economy. The program has a practice-oriented base using the modern laboratory "Sigma LABS" at the School of mathematics and cybernetics. Nowadays, the artificial intelligence modelling has two main approaches:

4. Machine intelligence, based on the strong task of the result of functioning;
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The one side represents, that the most important fact is the result. It means, that the main idea focuses on the concurrence of artificial and natural intelligent systems, but not on the process of formulation of behavior through the internal mechanisms.

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		various technical devices, in case that the "behavior" of such devices concurs with a human behavior according to the certain limits. The development of this area is closely related to the studying of human sciences. It includes wider spectrum of rational human activity comparing with the machine intelligence. The artificial intelligence systems are based on the mathematical interpretation of the activity of the human brain nervous system. Thus, they are realized as neural networks, based neural element as an analog of a neuron.
7	Type of EP	PhD
8	NRC level	8
9	Level on OCR	8
10	Distinctive features of the EP	The special feature of this program is the preparation of graduates capable of carrying out the following types of professional activity: - teaching; - research; - organizational and managerial; - production and technological.
11	List of competencies of the educational program:	professional activity in the field of computer programming; - conducting scientific research, technical testing and analysis, experimental developments in the field of natural sciences and engineering; work in the field of public administration of a general nature; - management activities of parent companies, other professional, scientific and technical activities in the field of engineering surveys and the provision of technical consultations in this field; - specialist, leading specialist, leading engineer, software engineer in organizational and managerial organizations; - research fellow in research institutes; - in research organizations as a research fellow, leading engineer or mathematician-programmer as a developer of mathematical models of physical, chemical and technological processes; - in design organizations as a developer of mathematical and computer models, a mathematician-programmer; - in organizational and technological organizations as a mathematical engineer, a mathematical programmer, a developer

		of mathematical and computer models, or a computer science specialist; - in production and management organizations as a mathematician, programmer and IT specialist. Doctoral students can undergo practical training and have the opportunity to find employment in all banks of the Republic of Kazakhstan, , in KazMunayGas and other oil and gas companies, in the Institute of Mathematics and Mathematical Modeling, in the Institute of Information and Computational Technologies, in the "National Scientific Laboratory for Collective Use, Information and Space Technologies, in Ozel Trade & Co LLP, in the Sigma LABS Laboratory at the Mathematics Department at KazNITU named after K.I. Satpayev and the Institute of Technology and Technology at KazNITU named after K. I. Satpayev. Doctoral students can undergo training and internships at foreign universities within the framework of academic mobility and other forms of cooperation. In this regard, our partners are the Lublin University of Technology (Poland), Bielsko-Biala University (Poland), L'Aquila University (Italy), New York University, Girne American University (Cyprus), Windsor University (Canada). Work on establishing cooperation with foreign universities is actively continuing.
12	Learning outcomes of the educational program:	LO 1 - Integrate the knowledge gained within different disciplines to solve research problems in new unfamiliar conditions and generate new ideas in the context of scientific research in the field of cybernetics and artificial intelligence. LO 2 - Apply different types of models used in the development of artificial intelligence systems, describe the relationship between models and the development of artificial intelligence systems. Create analytical systems and recommend services based on machine learning and deep learning algorithms. LO 3 - Apply machine learning methods in relation to big data processing tasks, conduct scientific research, organize work on collecting, storing and processing information. LO 4 - Apply the methodology of scientific cognition, principles and structure of scientific research, use experimental and theoretical research methods in the field of cybernetics and artificial intelligence. LO 5 - Create quantum circuits and perform analysis, use quantum algorithms in the implementation of calculation methods. LO 6 Conduct a stylistic analysis of scientific, scientific,

		technical and popular science texts, apply the methodology of working with text, including searching for information in reference, specialized literature and computer networks, use the skills of oratory, the correct and logical formulation of one's thoughts in oral and written form. LO 7 - Organize and plan research, set specific tasks for scientific research in the field of quantum computing, and solve them with the help of modern devices and equipment. LO 8 - Extract the necessary information from various sources, including information flows in real time, develop scientific and technical innovative solutions for the information infrastructure of the enterprise, taking into account the capabilities of big data technologies. LO 9 - Be able to analyze and predict trends in the training of specialists in the field of intellectual property law in the global market, develop strategies for the protection and commercialization of intellectual property.
13	Form of training	Full-time
14	Duration of training	3 years
15	Volume of credits	180
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree	PhD
18	Developer(s) and authors:	Lukpanova L.H., Tulesheva G.A.

4.2 Interrelation of achievability of the learning outcomes of the educational program and academic disciplines

№	Name of discipline	Brief description of the discipline	Number of credits	Formable learning outcomes (codes)								
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9
CYCLE OF BASIC DISCIPLINES (BD) **Module of basic training (university component)**												
1	Academic writing	Objective: to develop academic writing skills and writing strategies for doctoral students in engineering and natural sciences. Content: fundamentals and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, and references; in-text citation; preventing plagiarism; and preparing a conference presentation.	5						v			
2	Methods of scientific research	Purpose: It consists in mastering knowledge about the laws, principles, concepts, terminology, content, specific features of the organization and management of scientific research using modern methods of scientometry. Contents: structure of technical sciences, application of general scientific, philosophical and special methods of scientific research, principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, computer science and engineering research in theory and practice.	5				v			v		
Cycle of basic disciplines **Component of choice**												

5	Intellectual property and the global market	Purpose: the goal is to train specialists in the field of intellectual property law who can analyze and predict trends in its development in the global market, develop strategies for the protection and commercialization of intellectual property. Contents: global aspects of intellectual property and its role in international trade and economics, analysis of international agreements and conventions, IP management strategies, cases of protection and violation of intellectual property rights in various jurisdictions.	**5**									**v**
6	Advanced Machine Learning Methods	Purpose: developing skills in the practical application of machine learning methods for constructing formal mathematical models and interpreting modeling results when solving problems in various applied areas. Content: theoretical knowledge of the basics of machine learning for building formal mathematical models and interpreting simulation results; machine learning methods, methods for constructing algorithms that can learn.	5			**v**						
CYCLE OF PROFILE DISCIPLINES (PD) Module of professional activity (component of choice)												

11	Data mining	Objectives: study of modern methods of data analysis and familiarization with real tasks solved with their application. The course provides a logical connection between the additional chapters of the disciplines of the mathematical cycle with disciplines related to programming, computer modeling. In the process of studying the discipline, doctoral students get acquainted with modern methods of machine learning.	5								v	
	Quantum computing	The course contains basic information on quantum theory in a presentation intended for doctoral students with basic mathematical and programming training: the space of quantum states, operators of physical quantities, the Schrodinger equation, the Hartree-Fock method, the Monte Carlo diffusion method. The initial information from the theory of quantum computers is given.	5					v				
	Application of the theory of fractals in mathematical modeling	Purpose: in-depth study of fractal sets, their properties, methods of research and construction, acquisition of knowledge about the possibility of describing many natural processes and phenomena using the theory of fractals. Content: new effective ways of mathematical description of complex phenomena, methods of fractal analysis of time series; dimension of fractal objects; possibilities of practical application of the ideas of fractal geometry.	5	v								
	Machine learning theory	The purpose of mastering: to create intelligent control systems, pattern recognition, forecasting in all spheres of human activity. Topics studied include: supervised learning; unsupervised learning; learning theory (trade-offs/compromises, practical advice); reinforcement learning and adaptive management. The latest machine learning applications, such as robotic control, data mining, autonomous navigation, speech recognition, text and web data processing, will also be discussed.	5		v	v						

NAO "KAZAKH NATIONAL ISSUE TECHNICAL UNIVERSITY
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