Non-profit Joint Stock Company "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATPAYEV"

SATBAYEV UNIVERSITY

Institute of Automation and Information Technologies
Department of Electronics, Telecommunications, and Space Technologies

EDUCATIONAL PROGRAM
8D06201 – "Telecommunications"

Code and classification of the field of education:
8D06 – Information and Communication Technologies
Code and classification of the training program:
8D06201 – Telecommunications
Group of educational programs:
096 – Communications and Communication Technologies
Level according to NQF: 8
Level according to BRQ: 8
Duration of study: 3 years
Credit volume: 180

Almaty 2025

Non-profit Joint Stock Company "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATPAYEV"

The educational program 8D06201 – "Telecommunications" was approved at the meeting of the Academic Council of Satpayev KazNITU.

Protocol № __ of "___" ____2025 y.

Reviewed and recommended for approval at the meeting of the Academic and Methodological Council of Satpayev KazNITU. Protocol № __ of "___" ____2025 y.

The educational program 8D06201 – "Telecommunications" was developed by the Academic Committee for the field 096 – Communications and Communication Technologies.

Full name	Academic degree / academic title	Post	Place of work	Signature
Chairman of the Academic Committee:				
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Teaching staff:				
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Marksuly S.	m.t.s	Senior Lecturer	"KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATPAYEV"	
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Contents

List of abbreviations and designations

ILP – Individual Learning Plan
EP – Educational Program
NQF – National Qualifications Framework
SQF – Sectoral Qualifications Framework

IoT – *Internet of Things*
Wi-Fi – *Wireless Fidelity* (Wireless Network)
LoRa – *Long Range* (Long-Range Wireless Technology)
NB-IoT – *Narrowband IoT* (Narrowband Internet of Things)
5G/6G – Next-Generation Mobile Networks (Fifth/Sixth Generation)

Description of the educational program

1.1 Program Scope and Content

The doctoral program in the field of "Telecommunications" includes the study of the following innovative disciplines:

- Methods and technologies for information protection in simulated telecommunications systems;
- Modeling and optimization of telecommunications systems and networks;
- Sustainable development science;
- Mathematical computer modeling in telecommunications;
- Basic concepts of cognitive and adaptive networks;
- Development and research of fiber-optic sensors;
- Intelligent systems.

The PhD must:

Be knowledgeable about:

- Modern telecommunications technologies, current scientific achievements, and global trends formed at international scientific and technical forums, including the development of the IoT (Internet of Things) ecosystem and its integration with 5G/6G next-generation networks.
- The development and research of software platforms and tools for modeling complex infocommunication systems that ensure the functioning of IoT devices based on various wireless data transmission technologies, such as Wi-Fi (Wireless Fidelity), LoRa (Long Range), and NB-IoT (Narrowband IoT).
- Architectures, development, and research of technical means for multiservice, intelligent, and secure communication networks capable of providing scalable connectivity for millions of IoT devices with high bandwidth and minimal latency.
- Principles of building, development, and research of neural networks and cyber-physical systems integrated with IoT and using the advantages of 5G/6G for applications in smart cities, industrial automation, and telemedicine.
- Methodologies for conducting scientific research, methods of development, transmission, protection of information, and control of telecommunications process parameters in conditions of mass IoT device connectivity.
- Architectures for centralized and distributed data processing, as well as the development and research of wired, wireless, and mobile communication technologies required for effective support of IoT applications in multiservice telecommunications environments.

Know:

- Scientific approaches to the development and research of telecommunications systems.
- Methods for analysis, synthesis, and optimization of architectures of intelligent communication networks.
- Principles of the development and protection of cyber infrastructures.
- Modern scientific methodologies in the field of data processing, storage, transmission, and protection.

- Technological and research tools for developing multiservice and secure networks.

Be able to:

- Formulate and solve fundamental and applied scientific tasks, including the development and research of innovative solutions in telecommunications.
- Develop, model, and optimize telecommunications systems using modern scientific methods.
- Analyze initial data, design, research, and improve intelligent and adaptive networks.
- Develop and research software tools for mobile, distributed, and cloud systems.
- Define scientifically justified requirements for telecommunications systems, develop recommendations and projects for their modernization based on advanced technologies.

Professional skills:

- Mastery of architectures of intelligent telecommunications systems (neural network-based, expert systems, multi-agent systems);
- Knowledge of the legal and regulatory framework in the ICT and telecommunications sector;
- Organization of collection, storage, and processing of telecommunications data;
- Participation in the design, implementation, and maintenance of intelligent telecommunications solutions.

Types of professional activities:

1. **Production and technological**:

- Implementation of telecommunications systems in enterprises, participation in the digitalization of industries.

2. **Organizational and managerial**:

- Project and team management, interaction with telecommunications solution clients, development of plans and technical documentation.

3. **Scientific and research**:

- Mathematical and digital modeling of telecommunications processes, conducting experiments, analysis, and preparation of scientific publications.

4. **Project and design calculations**:

- Design of networks and communication systems, use of measuring instruments, configuration, and commissioning of equipment.

5. **Pedagogical and innovative**:

- Study of international experience, development of analysis and forecasting methods, introduction of new technologies and equipment in the telecommunications field.

The program includes production practices at enterprises such as:

- JSC "Kazakhtelecom", subsidiaries of Kazakhtelecom, LLP "KaR-Tel", "Beeline", JSC "Transtelecom", LLP RTeL, Jusan Mobile, JSC "ALTEL", JSC "KazTransCom", Freedom Telecom, JSC "Kazteleradio", JSC "Kazpost", etc.

Scientific internships are also provided at:

- Lublin University of Technology (Poland), St. Petersburg State Technical University (Russia), Riga Technical University (Latvia), University of Nice Sophia-Antipolis, France, Xinjiang University (China), Penza State University (Russia, Penza), Novosibirsk State Technical University (Russia, Novosibirsk), Ariel University (Israel), Humboldt University (Germany), Moscow Technical University of Communications and Informatics (Russia), Hokkaido University (Japan).

1. Goal and Objectives of the Educational Program

Goal of the Program: The preparation of highly qualified specialists and researchers in the field of telecommunications, capable of developing, modeling, optimizing, and protecting modern telecommunications systems and networks, as well as creating innovative solutions based on intelligent, cognitive, and adaptive technologies. The program aims to form in-depth knowledge and skills in information security, mathematical and computer modeling in radio-electronic technologies, the development and research of fiber-optic sensors, as well as the application of sustainable development principles in the telecommunications industry.

Objectives of the Program:

- Provide fundamental and applied training for doctoral students in modern telecommunications.
- Develop competencies in methods and technologies for information protection in simulated telecommunications systems.
- Foster skills in mathematical, computer, and simulation modeling, as well as the optimization of telecommunications systems and networks.
- Teach the principles of cognitive and adaptive networks, as well as intelligent systems.
- Provide knowledge on the development and research of fiber-optic sensors for use in telecommunications.
- Form an understanding of sustainable development principles and their implementation in the telecommunications industry.
- Prepare doctoral students for conducting scientific research and experimental design work in the telecommunications field.
- Promote the development of skills in independent scientific activity, preparing scientific publications, and implementing research results into practice.
- Ensure a level of training that allows graduates, after defending their PhD, to make a significant contribution to the development of science, create new technologies and solutions in telecommunications, and manage large-scale research projects.

3. **Requirements for Assessment of Learning Outcomes of the Educational Program**

The doctoral program 6D06201 - "Telecommunications" ensures that doctoral students achieve all planned learning outcomes necessary for successful scientific, research,

teaching, and innovative activities in the field of modern telecommunications systems and technologies.

Assessment of learning outcomes is based on:

- Completion of the doctoral student’s scientific research work (NIRD) with the submission of interim and final reports.
- Publications in peer-reviewed scientific journals, including those indexed in international databases (Scopus, Web of Science, etc.).
- Completion of an international scientific internship to expand international scientific experience, establish research connections, and master advanced technologies.
- Completion of pedagogical practice to develop teaching skills, methodological work, and academic mentoring.
- Participation in international and national scientific conferences.
- Successful preparation and public defense of a doctoral dissertation on a relevant topic in the telecommunications field.
- Confirmation of scientific results that are novel and significant for the development of the industry.

The graduate of the program must demonstrate the ability to:

- Independently formulate and solve world-class scientific tasks.
- Develop and research innovative telecommunications solutions.
- Effectively combine scientific research and teaching activities.
- Make a significant contribution to the development of science, education, and technology at both national and international levels.

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 technologies
2	Code and classification of areas of training	8D06201-Telecommunication
3	Group of educational programs	096 Communications and Communication Technologies
4	Name of the educational program	8D06201-Telecommunication
5	Brief description of the educational program	The educational program "Telecommunications" is aimed at training specialists, **the educational program "Telecommunications" (doctoral studies)** is aimed at training highly qualified specialists in the field of telecommunications and information and communication technologies who are able to solve fundamental and

		applied scientific problems, conduct interdisciplinary research, develop and implement innovative solutions in the field of digital communication systems. next-generation networks (5G/6G), Internet of Things (IoT), artificial intelligence and cybersecurity. The program is focused on the formation of research, project, pedagogical and managerial competencies necessary for work in research centers, universities, IT companies and industry organizations.
6	Purpose of the EP	Training of highly qualified specialists with fundamental educational, methodological and research training; possessing competencies in the field of solving scientific and organizational and production processes, ensuring high-quality performance of functional duties, mobility in the professional labor market, knowing the latest world achievements and prospects for the development of the telecommunications industry.
7	Type of EP	New
8	NQF level	8
9	SQF Level	8
10	Distinctive features of the EP	No
11	List of competencies of the educational program:	*Requirements for the key competencies of graduates of doctoral studies in Telecommunications:* **1) Have an idea:** – on modern methods of construction and design of telecommunication systems, taking into account the trends and patterns of development of domestic and world science in the context of globalization and digitalization; – on modern software tools for research, modeling and design of communication systems; – on technical and hardware solutions used in the construction and operation of telecommunication networks of a new generation; – on the main stages of development and change of scientific paradigms in the field of communications and information and communication technologies; - about the subject and methodological specifics of technical sciences in the field of telecommunications; - about the leading scientific schools in the field of telecommunications, their theoretical foundations and practical developments; - about the scientific concepts of world and Kazakhstani science in the field of telecommunications. **2) Be able to:** – organize, plan and implement the process of scientific research in the field of telecommunications;– analyze, evaluate and compare various theoretical concepts and

		approaches to the design of telecommunication systems;– collect and process information from various sources, including big data;– conduct independent scientific research characterized by academic integrity, based on modern theories and methods of analysis;– generate their own scientific research ideas, expand the boundaries of industry knowledge and convey the results to the scientific community;- select and effectively use modern methodologies of scientific analysis and digital modeling;- plan and predict their professional development in science and the communications industry;- form problem statements, develop mathematical and functional models, simulate the operation of telecommunication systems using modern software platforms;- develop algorithms and software solutions for intelligent telecommunication systems. **3) Know:** – current trends and directions in the development of science in the field of telecommunications in Kazakhstan and abroad;– methodology of scientific knowledge in engineering and technical research;– achievements of world and Kazakhstani science in the field of communications and infocommunications;– methods of analysis and construction of telecommunication systems in various applied areas;– predictive assessments of the development of technical means and platforms of telecommunications;– regulatory and methodological materials regulating the design, implementation and operation of telecommunication systems;– methods of ensuring information security, reliability and quality of functioning of equipment and communication networks. **4) Have the skills to:** – critical analysis, evaluation and comparison of various scientific approaches in the telecommunications industry;– implementation of applied and experimental research;– planning and forecasting of scientific results;– public speeches and scientific presentations at international conferences and forums;– scientific writing and effective scientific communication;– planning and coordination of research processes within the framework of projects and dissertations;– systematic understanding of the subject area, and substantiation of the applied scientific methods and solutions;- participation in fundamental and applied scientific projects;- leadership, organization of the work of the research team;- protection of intellectual property and respect for the rights to scientific development;- knowledge of a foreign language at the level necessary for scientific communication and international cooperation;- organization of data collection, storage, analysis and processing in the telecommunications sector.

		Professional activity of graduates Graduates of doctoral studies in Telecommunications can carry out professional activities in the following areas: science and education, public and digital management, telecommunications and IT industry, industry, transport, healthcare, finance and energy. **Objects of professional activity:** – telecommunication systems and networks of various levels and purposes;– software and hardware of communication systems;– digital platforms and services of telecom operators;– fixed, mobile, satellite and wireless communication infrastructure;– academic and research organizations;– digitalization centers and industry engineering companies. **The main functions of professional activity:** – design, operation, administration and modernization of telecommunication systems;– ensuring the sustainability, security and efficiency of information and communication networks;– research and teaching activities;– participation in the implementation of digital transformation projects and innovations in the field of communications. **Areas of professional activity:** – development and implementation of intelligent communication systems;– design of multi-service and mobile communication networks;– maintenance and operation of telecommunications management systems;– implementation of scientific projects in the field of telecommunications and information and communication technologies. *Tasks of a PhD doctoral student by type of professional activity:* **In the field of organizational and managerial activities:** – to manage ICT departments, project and scientific groups in the field of communications. **In the field of experimental and research activities:** – to manage a laboratory or a scientific department for theoretical and applied research in the field of telecommunications. **In the field of research and pedagogical activities:** - to be a leading researcher, teacher of specialized disciplines at all levels of higher education;- to develop and implement research and educational projects. **In the field of design and engineering:** – manage departments engaged in the development and implementation of telecommunications solutions in various sectors of the economy.
12	Learning outcomes of the educational program:	PO1 Be able to demonstrate a set of personal qualities, scientific, pedagogical, professional competencies and ethical decisions in professional

		activities PO2 Be able to develop or transfer new knowledge in information and communication systems, energy efficiency and adapt the best world practices for domestic telecommunications PO3 Be able to apply advanced scientific achievements and knowledge in the field of telecommunications to systematically study, evaluate and synthesize new concepts in order to answer important scientific questions in infocommunication and improve existing knowledge or professional practice PO4 Be able to demonstrate a sustained interest in creating new higher-level network and communication concepts and telecommunications management PO5 Be able to defend and defend positions on informed decisions of existing and new models of information transmission systems in professional discussions and decision-making structures PO6 Plan and conduct independent research to generate new knowledge and applications; make informed judgments on integrated data transmission systems.
13	Form of study	Full-time
14	Duration of training	3 years
15	Volume of credits	180 credits
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree awarded	Doctor of philosophy PhD
18	Developer(s) and authors:	Tashtay E Taysarieva K.N

4.2. The relationship between the achievability of the formed learning outcomes under the educational program and Academic Disciplines

№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)						
				PO1	PO2	PO3	PO4	PO5	PO6	PO7
A cycle of basic disciplines University component										
1	Scientific research methods	Goal: 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 scientometrics. Content: the structure of technical sciences, the application of general scientific, philosophical and special methods of scientific research, the principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, informatics and engineering research in theory and practice.	5	v	v			v		
2	Academic writing	Objective: To develop academic writing skills and writing strategies in doctoral students in engineering and natural sciences. Content: the basics and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, conclusion, literary sources used; citation in the text; prevention of plagiarism, as well as writing a presentation at a conference.	5		v					
A cycle of basic disciplines Optional component										

3	Methods and technologies of information protection in simulated telecommunication systems: purpose, study of the discipline	This discipline is devoted to the study of methods, technologies and approaches to ensuring information security in telecommunication systems subjected to modeling and analysis. The course examines modern cybersecurity threats, data protection mechanisms, and ways to ensure the confidentiality, integrity, and availability of information.	5		v					
4	The science of sustainable development	Objective: To provide doctoral students with a deep understanding of the interactions between natural and social systems, as well as to develop skills to identify and develop strategies for sustainable development that contribute to the long-term well-being of humanity and the preservation of the environment. Content: complex relationships between ecosystems and societies, and delve into the analysis of sustainability issues at the local, national and international levels.	5	v	v			v		
Cycle of major disciplines Optional component										
5	Development and research of fiber optic sensors	The discipline is designed to solve problems arising from the development and operation of new innovative telecommunications equipment and technologies. The main technical characteristics of fiber-optic components and methods for conducting photometric and optical measurements and research, including the use of ready-made methods, technical means and processing of the results obtained. Mathematical description and modeling. Study of methods for monitoring reliability parameters taking into account the fundamental differences between fiber-optic components and electronic ones. Practical recommendations for the construction of traditional and	5	v	v			v		

		original digital fiber-optic systems and their elements. To perceive, process, analyze and systematize scientific and technical information, advanced domestic and foreign experience in the field of fiber optic sensors.								
6	Intelligent systems	Study of the main tasks of IS, the theoretical foundations of artificial intelligence (AI). Presentation of tasks in natural and formalized languages. Fundamentals of the mathematical logic of events and the theory of probability in decision-making. Neural network training strategy. Theory of static learning. Methods of decision-making, Possibilities of using AI. Dynamic recovery. Architecture of recurrent networks. Formal systems. A model in a state space. Real-time recurrent learning.	5	v					v	v
7	Mathematical and computer modeling in RET	General issues of building mathematical models of RET components. Mathematical models of design objects. Models of technological processes. Models of discrete elements. Theoretical foundations of computer modeling. Electrical models of integrated circuits. Computer modeling of telecommunications elements and research. Information Systems for Computer Modeling. Describes modeling languages and digital device elements in logical layer models. Synchronous simulation of digital devices.	5	v			v		v	v
8	Basic Concepts of Cognitive and Adaptive Networks	The discipline "Cognitive and Adaptive Networks" is devoted to the study of intelligent technologies for managing telecommunication systems that are able to adapt to changing environmental conditions, optimize the use of resources and increase the efficiency of network interaction. The course covers the key concepts of cognitive networks, machine learning in telecommunications, adaptive algorithms, and modern approaches to building next-generation networks.	5				v			v

5. Curriculum of the educational program

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“KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATBAYEV”

SATBAYEV UNIVERSITY

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

WORKING CURRICULUM

Academic year	**2025-2026 (Autumn, Spring)**
Group of educational programs	**B059 - "Information and communication technologies"**
Educational program	**8D06201 - "Telecommunication"**
The awarded academic degree	**Doctor of Philosophy PhD**
Form and duration of study	**full time (scientific and pedagogical track) - 3 years**

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters						Prerequisites
									1 course		2 course		3 course		
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)															
CYCLE OF BASIC DISCIPLINES (BD)															
M-1. Module of basic training															
LNG305	Academic writing		BD, UC	5	150	0/0/45	105	E	5						
CSE339	Research methodology		BD, UC	5	150	30/0/15	105	E	5						

ELC336	Methods and technologies of information protection in simulated telecommunication systems	1	BD, CCH	5	150	30/0/15	105	E	5						
MNG350	Sustainability Science	1	BD, CCH	5	150	30/0/15	105	E	5						
M-3. Practice-oriented module															
AAP350	Pedagogical practice		BD, UC	10				R		10					
CYCLE OF PROFILE DISCIPLINES (PD)															
M-2. Module of professional activity (component of choice)															
ELC303	Mathematical and computer modeling in the RET	1	PD, CCH	5	150	30/0/15	105	E	5						ELC215, ELC220
ELC337	Basic concepts of cognitive and adaptive networks	1	PD, CCH	5	150	30/0/15	105	E	5						
ELC319	Development and research of fiber optic sensors	2	PD, CCH	5	150	30/0/15	105	E	5						
ELC301	Intellectual systems	2	PD, CCH	5	150	30/0/15	105	E	5						ELC218, ELC205
M-3. Practice-oriented module															
AAP355	Research practice		PD, UC	10				R			10				
M-4. Experimental research module															
AAP336	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	5				R	5						
AAP347	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	20				R		20					

AAP347	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	20				R			20				
AAP356	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	30				R				30			
AAP356	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	30				R					30		
AAP348	Research work of the doctoral student, including internships and doctoral dissertation		RWDS	18				R						18	
M-5. Module of final attestation															
ECA325	Final examination (writing and defending a doctoral dissertation)		FA	12										12	
Total based on UNIVERSITY:									30	30	30	30	30	30	
									60		**60**		**60**		

Number of credits for the entire period of study

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

	Student				
FA	Final attestation				12
TOTAL:					**180**

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

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