«Mukhametzhan Tynyshbayev ALT University» JSC

I APPROVE
Chairman of the «ALT University» JSC
_____ M.S.Zharmagambetova
Decision of the Academic Council of
«ALT University» JSC
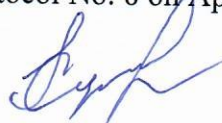from " 30 " ___05___ 2025 year (Protocol № 10)

PROGRAM
THE ENTRANCE EXAM TO THE DOCTORAL PROGRAM

Group of educational programs
"D100 - Automation and control"

Almaty, 2025

The program of the entrance exam was discussed and received a positive decision at the meeting of the Department of Automation and Control, Protocol No. 8 on April 28, 2025.

Head of the department of "AU"   G.A.Suleimenova

The program of the entrance exam was reviewed and recommended at the meeting of the Council of the Institute of Energy and Digital Technologies, Protocol No. 10 dated May 28, 2025.

Chairman of the Board of the Institute "EiCT"   Togozhinova A.Zh.

CONTENT

1. The purpose of the entrance exam for a group of educational programs

The purpose of the entrance examination for the groups of educational programs is to determine the theoretical and practical readiness of the applicant for doctoral studies, as well as the level of knowledge, skills, and competencies in accordance with the requirements of doctoral training in the relevant field of study.

The doctoral entrance examination consists of writing an essay and passing an exam in the profile of the educational program group.

2. Regulations for conducting the entrance exam for doctoral studies in a group of educational programs

The duration of the entrance examination is 3 hours and 30 minutes, during which the applicant writes an essay and answers an electronic exam ticket consisting of 3 questions. The list of questions and the essay topic are generated randomly. The maximum score for the entrance examination is 100 points, distributed as follows: essay writing – 20 points, exam on the educational program profile – 50 points, and interview – 30 points.

3. Types and evaluation criteria

3.1 Types and criteria of essay evaluation

Types of essays	Description	The volume of the essay
Motivational	The applicant's argumentation about the motivations for research activities (research statement)	At least 250 words
Scientific and analytical	Substantiation by applicants of the relevance and methodology of the proposed research (research proposal)	
Problem-themed	Presentation of the author's position on relevant aspects of subject knowledge	

Criteria	Descriptors	Scores
Depth of topic disclosure	The problem is disclosed on a theoretical level, with the correct use of scientific terms and concepts, using information from various sources.	4

	his own point of view (position, attitude) is presented when solving the problem.	4
Argumentation, evidence base	the presence of arguments, the identification of cause-effect relationships, the ability to reason from the particular to the general, from the general to the particular.	4
Compositional integrity and logic of presentation	The presence of compositional integrity, the logical connection of the structural components of the essay, the presence of conclusions and generalizations	4
Speech culture	demonstration of an advanced level of academic writing (vocabulary, knowledge of scientific terminology, grammar, stylistics)	4
Maximum number of points		20

3.2 Criteria for evaluating the answers to the questions of the electronic examination card

The exam in the profile of the group of educational programs includes 3 blocks of questions, of which: the 1st question determines the level and consistency of theoretical knowledge; the 2nd question reveals the degree of formation of functional competencies; the 3rd question is aimed at determining systemic competencies. The maximum number of points is 50.

The electronic exam ticket consists of 3 questions:

Blocks	The nature of the question	Number of points
1st question	theoretical -determines the level and consistency of theoretical knowledge	10
2nd question	practical - reveals the degree of formation of functional competencies (the ability to apply techniques, technologies and techniques in the subject area)	20
The 3rd question	it reveals a systematic understanding of the subject area under study, specialized knowledge in the field of research methodology (system competencies)	20
TOTAL		50

Criteria for evaluating the answers to the questions of the electronic examination card:

Question	Evaluation criteria	Number of points
1st question	demonstrates knowledge of the main processes of the subject area under study; the depth and completeness of the disclosure of the issue	5

	logically and consistently expresses his own opinion on the issue under discussion	3
	knows the conceptual and categorical apparatus, scientific terminology	2
TOTAL		10
2nd question	applies methods, techniques, and technologies to solve problems in the subject area	7
	argues, compares, classifies phenomena, events, processes; draws conclusions and generalizations based on practical skills	7
	analyzes information from various sources	6
TOTAL		20
The 3rd question	critically analyzes and evaluates theoretical and practical developments, scientific concepts and current trends in the development of science	7
	synthesizes methodological approaches in the interpretation of the main problems of subject knowledge	7
	identifies cause-and-effect relationships in the analysis of processes, phenomena, events	6
TOTAL		20
In total		50 points

3.3 Interview evaluation criteria

№	Criteria	Descriptors	Points
1.	Motivation	Argumentation of motives for studying for a doctoral degree in a selected OP and admission to a certain university. Vision of prospects for professional and personal growth upon completion of training.	5
2	Research competence	Possession of research skills and experience necessary for research activities in a specific subject area.	10
3.	Creativity	Non-standard thinking, creative and alternative approaches to solving problems, situational tasks.	10

4.	**Communicativeness**	The ability to briefly, representatively, logically, argumentatively state your point of view, make generalizations and conclusions. Language proficiency.	5
	Maximum number of points		**30**

4. Content of examination materials

4.1 Content of the Essay topic

№	The topic of the essay
1	Applying artificial intelligence and machine learning to train control systems: Explore the potential of AI to optimize schedules, prevent delays, increase capacity, and ensure safety. What are the challenges and prospects?
2	Development and implementation of unmanned technologies in railway transport: Analyze the technological, regulatory and social aspects of the transition to autonomous trains. Which harvester systems require the most improvement to support unmanned movement?
3	Cybersecurity of railway automation and telemechanics systems: Assess current cybersecurity threats to critical railway infrastructure and propose strategies to minimize them, including the use of blockchain technologies or advanced encryption techniques.
4	Integration of harvester systems with the concept of a "digital twin" of the railway: How can the creation of virtual models of railway infrastructure improve the planning, maintenance and monitoring of automation systems?
5	The use of predictive analytics and monitoring of the state of harvester equipment: How can using sensor data and machine learning help predict equipment failures and optimize maintenance schedules?
6	Development and application of new algorithms to improve the safety and reliability of railway traffic: Focus on innovative approaches to obstacle detection, speed control and collision prevention.
7	Standardization and unification of railway automation systems in an international context: Analyze the challenges and advantages of harmonizing railway automation standards to ensure cross-border traffic and compatibility.
8	The role of the human factor in the operation and maintenance of modern harvester systems: Explore the interaction between humans and highly automated systems, personnel training issues, as well as the impact of automation on workflows and decision-making.
9	Optimizing the operation of marshalling yards and station complexes: Explore how mathematical modeling and algorithms can improve the efficiency of sorting wagons, reduce downtime, and improve safety at stations.
10	Modeling and risk analysis in railway automation and telemechanics systems: Develop approaches to quantify the risks associated with equipment failures, software failures and

human factors, and propose measures to reduce them.

4.2 The content of the sections on the blocks submitted for the entrance exam

Examination materials for the entrance exams to the doctoral program for groups of educational programs, including the subject of essays, examination questions on the profile are made in three languages: Kazakh, Russian and English.

The topics of the examination questions correspond to the selected sections from the curricula of the cycles provided for by the groups of educational programs "D100 - Automation and control":

№	Name of disciplines
1	Computer systems of dispatching centralization
2	Interval train control systems
3	Automation of technical systems

4.3 The content of the sections on the blocks submitted for the entrance exam
Block 1
1.1. Microprocessor systems of dispatching centralization.

Introduction, the history of the development of computer systems of dispatching centralization, software issues. The operation of the central control devices during the formation and transmission of remote control signals. The main technical characteristics of the computer system. The block diagram of the equipment of the central post and controlled points. Construction of remote control and telesignalization signals in the DC of the Neman system

1.2. Prospects for the development of dispatch centralization systems.

The existing dispatch centralization systems in the CIS countries. Promising computer systems based on a new element base. Prospects for the creation of a production base and the solution of issues of software for computer systems of DC.

Block 2
2.1. Automatic locking systems.

Purpose and features of interval train control systems. Purpose, specifics and basic concepts of interval train control systems. The scope of application of DC self-locking, the principle of operation, advantages and disadvantages of the system. The purpose of the circuits, simplified two-wire and four-wire directional change circuits, the operation of the circuits in normal mode. Organizational and technical measures for the transition to two-way train traffic on one double-track stage, the principle of operation of the main circuit solutions

2.2. The perspective of the development of interval train control systems.

Microprocessor-based auto-locking systems. General characteristics, block diagrams, basic equipment and its characteristics, the principle of operation of the system. Train traffic control systems based on axle counters and other promising elements. Advanced moving alarm and dispatch control systems.

Block 3
3.1. Control objects in technical systems.

Classification of control objects in technical systems and their types, features of technical systems as control objects, linear and nonlinear models. Analytical and experimental methods for

determining the static and dynamic characteristics of control objects. General provisions on information support of the management process. Principles of obtaining and converting technological information.

3.2. Optimal controls in technical systems.

The main methods for solving problems of modeling technical systems, an idea of the use of application software packages for modeling. Algorithms for optimizing static modes by directly searching for an extremum on the control object using a mathematical model. A comparative analysis of algorithms for optimizing static modes with a direct search for an extremum at the control object.

4.4 Interview questions

1. What are your academic strengths?
2. What are your academic shortcomings and how have you dealt with them?
3. What are your most significant scientific achievements to date?
4. What are your research interests?
5. What are your professional goals?
6. What attracted you to this field in the first place?
7. What is your motivation for obtaining this degree (PhD)?
8. What do you think significant trends in your field of research?
9. What interests you to want to participate in our program?
10. What do you consider your most significant achievement?
11. What are the goals and objectives of the automation industry?
12. What is the purpose of the railway automation and telemechanics industry?
13. What is the reliability of the system and its criteria?
14. What is the description of the terms automatic and automated?
15. What modern railway automation and telemechanics systems do you know?

5. Recommended literature
5.1 Basic literature

1. Glazunov L.P., Grabotsevtskiy V.P., Fundamentals of the theory of reliability of automatic control systems: Moscow, Route, 2005 – 255 p.

2. Dudnikov E.G. Automatic control in industry / Textbook for universities of railway transport. – 3rd ed., reprint. and additional – M.: Transport, 2004. – 168 p.

3. Stefani E.P., Fundamentals of building automated process control systems M.: Energia, 2006. – 352s.

4. Cirlin A.M., Optimal control of technological processes, M.: Energoizdat 2006- 400 p.

5. Vasilkov Yu.V., Vasilkova N.N., Computer computing technologies in mathematical modeling: Moscow: Finance and Statistics, 2002 - 265 p.

6. Olson G., Piani D., Digital automation and control systems, St. Petersburg: Nevsky dialect, 2001- 557 p.

7. Kochetkov A.A. Remote control systems in railway transport, Moscow, Route, 2005 – 304 p.

8. Satyrev F.E., Golik V.K., Dispatch centralization "Neman", RB, Gomel, 2003 – 106 p.

9. Dolgiy I.D., Kulkin A.G., Dispatching control system and train traffic management DC – South with RCP, Rostov on Don, RGUPS, 2010 – 468 p.

10. Vinogradova V.Yu., Voronin V.A., Kazakov E.A., Shvalov D.V., Shukhina E.E. Distillation automation systems. Moscow, Route, 2005. – 292 p.

11. Fedorov N.E. Modern auto-locking systems with tonal rail circuits. Samara, SamGAPS, 2004. – 132 p.

12. Fedorov N.E. Relay and microelectronic systems of interval control of train movement. Samara, SamGAPS, 2006. – 163 p.

5.2 Additional literature

1. Longbotov R.I., Reliability of computing systems: Moscow, Energia, 2001 – 216 p.

2. Shultz V.A., Methodological guidelines for the implementation of practical exercises. Almaty, KazATK 2010- 32s.

3. Shultz V.A., Textbook "Dispatch centralization". Almaty, KazATK 2010- 86c.

4. Technical operation of devices and systems of railway automation and telemechanics: a textbook / Edited by Doctor of Technical Sciences V.V. Sapozhnikov. - M: Route, 2003.- 335s.

5. Mankwein V.T., Frolov S.V., Shekhtman M.B., Application of Scada systems for automation of technological processes. Moscow: Tambov: Mechanical Engineering, 2000.- 176 p

6. Aristova N.I., Korneva A.A., Industrial software and hardware on the market of automated process control systems, M.: Nauktehizdat 2001.- 400 p .

7. Denisov A.A., Kolesnikov D.N., Theory of large control systems, L.: Energoizdat 2000- 228 p.

8. Vedernikov B.M. Automation and telemechanics on stages. A study guide. KazATK, Almaty, 2009. – 109 p.

9. Vedernikov B.M. Automatic and semi-automatic locking. A study guide. KazATK, Almaty, 2009. – 132 p.

10. Vedernikov B.M. Travel sensors. A study guide. KazATK, Almaty, 2011. – 122 p.

11. Vedernikov B.M. Signal auto-regulation. Almaty, KazATK, 2009. – 92 p.

12. Vedernikov B.M. Automatic fencing devices on stages. Almaty, KazATK, 2008. – 100 p.

13. Vedernikov B.M. Methodological guidelines for practical classes in the discipline "Interval train control systems" (for undergraduates of the specialty 6M070200 – Automation and control). Almaty, KazATK, 2010. – 44 p.

14. Vedernikov B.M. Methodological guidelines for the independent work of a graduate student under the guidance of a teacher in the discipline "Systems of interval regulation of train traffic". Almaty, KazATK, 2010. – 40 p.