NON-PROFIT JOINT STOCK COMPANY
"ALMATY UNIVERSITY OF POWER ENGINEERING AND TELECOMMUNICATIONS NAMED AFTER GUMARBEK DAUKEYEV"

Approving
Vice Rector for Science
_____ Alipbayev K.A.
"___" _____ 2026 y.

PROGRAM

Entrance examination to the doctoral program in the direction

8D07104 – Instrumentation

Almaty 2026

The program is compiled in accordance with the Technical Specification for the formation of a database of examination materials for entrance exams to doctoral studies in groups of educational programs (MES RK) with taking into account the Modular curriculum of the educational program 8D07104 – Instrumentation.

This program sets out the requirements for a mandatory minimum of knowledge for admission to doctoral studies and the level of applicants to doctoral studies.

The program was reviewed and approved at the meeting of the AEE Department. Protocol no. 9 from "19" 05 2026 y.

Head of the AEE Department _____ Y. Nurgizat

The program was approved at a meeting of the educational and methodological commission of the Institute of Telecommunications and Automation.

Protocol no. 10 from 15.05 2026 y.

Director of the ITA _____ A. O. Omarbekova

The program of the entrance exam for doctoral studies in the educational program 8D07104 – Instrumentation has been coordinated with the Department of Science of the AUPET named after G.Daukeev.

Director of the Department of Science _____ Kalyeva N.B.

The program of the entrance exam for doctoral studies in the educational program 8D07104 – Instrumentation has been coordinated with the Department of Academic Affairs of the AUPET named after G.Daukeev.

Director of the Department of Academic Affairs _____ Baizakova S.M.

I. General Provisions

1. The program has been compiled in accordance with Order No. 600 of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018, "On Approval of the Standard Rules for Admission to Educational Institutions Implementing Higher and Postgraduate Education Programs" (hereinafter referred to as the Standard Rules), as amended.
2. The entrance examination for doctoral studies includes an interview, an essay, and an exam on the educational program group profile.

Block	Points
1. Interview	30
2. Essay	20
3. Exam on the educational program group profile	50
Total/passing	100/75

3. The entrance examination lasts 3 hours and 10 minutes, during which the applicant writes an essay and answers the electronic examination ticket. The interview is conducted at the university prior to the entrance examination.

II. Entrance Exam Procedure

1. Applicants to the doctoral program 8D07104 – " Instrumentation" write a problem-based/thematic essay. The essay must be at least 250 words long.

The essay's purpose is to determine the applicant's level of analytical and creative abilities, as expressed in the ability to construct their own arguments based on theoretical knowledge, social experience, and personal experience.

Essay Types:

- A motivational essay outlining the motivations for research;
- A scientific and analytical essay justifying the relevance and methodology of the planned study;
- A problem-based/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. The electronic examination form consists of three questions.

1. **Design of control and measuring devices and systems**

Topic 1 STM32 microcontrollers.

Classification of ARM Cortex microcontrollers

Topic 2 Cortex Core-M3.

Technical characteristics of Sortex-M3. The Cortex microprocessor core. Conveyor belt

Topic 3 Environment STM32Cube IDE.

Setting the RCC register to an external quartz resonator. Phase-locked frequency control Unit (PLL)

Topic 4 General purpose timers.

Generating interrupts at regular intervals. The structural basis of clocking

Topic 5 NVIC Interrupt monitoring module.

Setting up an interrupt. USART1_IRQn. Setting up two interrupts

LIST OF REFERENCES

BASIC LITERATURE

1. Vasiliev, A. V., Programming STM32 Microcontrollers in C. St. Petersburg: BHV-Petersburg, 2021

2. Kosarev, S. V., STM32 Microcontrollers: Architecture and Programming. Moscow: DMK Press, 2023

3. Yakovlev, A. N., ARM Cortex-M. STM32 Microcontrollers in Automation and Control Problems. Moscow: Solon-Press, 2020

4. Shilov, N. V., Systems on STM32 Microcontrollers: Design and Debugging. Moscow: Science and Technology, 2022

5. Vasiliev, A. S., Fundamentals of Microcontroller Programming. St. Petersburg: ITMO University, 2016. 95 p.

ADDITIONAL LITERATURE

6. Vodovozov, A.M., Microcontrollers for Automation Systems: A Tutorial – Moscow: Infra-Engineering, 2016. - 164 p.

7. Gusev, V.G., Electronics and Microprocessor Technology: - Moscow: KNORUS, 2013. - 800 p.

8. Dustin, E., Implementation, Control, and Automation – Moscow: Laurie, 2013. - 567 p.

9. Joseph, Y., The ARM Cortex-M3 Core. A Complete Guide – Moscow: Dodeka-XXI, 2012. - 552 p.

10. Fundamentals of Microcontroller Programming.
https://www.youtube.com/watch?v=finP05FFTv8

11. Learning STM32.
https://www.youtube.com/watch?v=vZVwv-EeHkI

12. Turning on an LED using STM32Cube IDE#STM32F103
https://www.youtube.com/watch?v=6J1-W3rbBWw

13. Anuchin A.S. Electric Drive Control Systems. – Moscow: MPEI Publishing House, 2015. - 873 pages.

14. Clemens B. The C Language in the 21st Century. – Moscow: DMK Press, 2015. - 365 pages.

15. Magda Yu.S., Programming and Debugging C/C++ Applications for ARM Microcontrollers. – Moscow: DMK Press, 2012. - 168 pages.

16. Novikov V.A., Electric drive in modern technologies. - M.: Academy, 2014 - 480 p.

2. Video surveillance and access control system

Topic 1 General information about VSS.

The purpose, structure of the VSS and the solved functional tasks of the blocks. Classification of video surveillance systems. The type of equipment used. Functional purpose. Location. The principle of management. The level of intelligence. The method of signal transmission. The type and number of video cameras used. Permission

Topic 2 Fundamentals of television.

The video signal. The RGB color model. Frame scan. The YUV model of the PAL standard. Composite signal. Visual information sensors. CCD video cameras with a photodiode array.

Topic 3 IP video surveillance.

Components of an IP video surveillance system. Image quality. HD-SDI connection. Block diagram of an IP camera. CCD arrays and CMOS arrays. The IR filter. An APS matrix pixel and an ACS matrix pixel. IP Cameras. Block diagram of an IP camera. The principle of operation of the IR filter. The photosensitive matrix. A video signal processor. The camera's web server.

Topic 4 Video Recording.

Options for organizing video recordings. The process of receiving video streams. The video recording server. Selecting a video recording device. The functionality of the video surveillance system. Software for its monitoring. Choosing a registrar or server. Hardware reliability. Integration of VSS with SFAS, ACMS and with ATMs. Video display. Characteristics of the monitors. IP video playback. Decoding problems. Graphics accelerators. Network equipment. Hub, switch, router, and server. Functions of DHCP, DDNS, NAT, STP, IGMP, VPN, VLAN.

Topic 5 Wireless connection and video analytics.

The purpose of video analytics. Detectors. Intelligent video surveillance systems. Video-speaking devices. Configuration of a video intercom consisting of one video camera and one monitor. Configuration of a two-level entrance video doorphone. VSS in the premises. Video surveillance system in the apartment. VSS on the perimeter. A typical video surveillance system in a bank.

LIST OF REFERENCES

BASIC:

1. Kasyanov V. A., Korobeynikov A. Yu. Video Surveillance and Access Control Systems: Design, Installation, and Operation. Moscow: DMK Press, 2022.

2. Borovikov S. V. Video Surveillance Systems and Security Technologies. Moscow: Solon-Press, 2020.

3. Kutsenko A. I. Technical Means of Security and Video Surveillance. Moscow: Infra-M, 2021.

4. Sitnikov S. V. Building Security Systems: Video Surveillance, Access Control, and Fire Alarm Systems. Moscow: Academy, 2019.

5. Krugl G. Practice and Technologies of Analog and Digital CCTV. Moscow: Security Focus, 2019. 626 p.

6. Alekseev, D. Yu. "The Practice of Designing Video Surveillance Systems Based on IP Cameras." Moscow: RadioSoft, 2020.

ADDITIONAL:

7. Damjanovsky, V. "The Bible of Video Surveillance." Translated from English. 2nd ed. Moscow: ISS Press, 2019. – 466 p.

8. Torsten, A., Keller, I. "Video Analytics: Myths and Reality." Translated from English. 2nd ed. Moscow: Security Focus, 2022. – 186 p.

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14. Vorona, V.A., Tikhonov, V.A. Technical Surveillance Equipment for Security Facilities. Moscow: Goryachaya Linya Telecom, 2011.

15. Kashkarov, A.P. Video Cameras and DVRs for Home and Car. Rostov-on-Don: Feniks, 2014. – 292 p.

3. PLC technologies in instrument engineering

Topic 1 PLC technologies.

General concepts and principles of information transmission. PLC technology standards. IEEE P1675 Standard for Broadband over Power Line Hardware. The HomePlug 1.0 standard describes the rules for the functioning of a local network. The HomePlug AV specification is a standard for working with large streams of information, with a video stream in HD quality (HDTV).

Topic 2 Theoretical foundations of Powerline technology.

Types of signal multiplexing, subcarrier phase modulation, relative quadrature phase shift keying (DQPSK). PLC technologies in automation systems. The standard G.hn. BPS is a high-speed data transmission technology (video streaming, IP telephony).

Topic 3 PLC adapter.

Adapters of the 3rd generation of the Homeplug AV2 standard with a wider frequency range. AVM FritzPowerline 1000E with a nominal speed of 1 Gbps. Testing of PLC adapters. The algorithm for testing the home network, the layout of control points with external interference. Control systems based on the RPi-3 microcomputer over low-voltage networks.

Topic 4 PLC-communication over low-voltage networks.

The structure of the GSM technology information transmission system and the principles of communication and power consumption control systems of the ACEMS. A PLC based on the Arduino platform. Components and operating principle of the PLC. Fixed (compact) The ARDBOX PLC. LAN based on PLC technologies.

Topic 5 Industrial controller CONTROLLINO MAXI.

Architecture and characteristics. I/O ports, interface. Programming of the Controllino Maxi PLC. Libraries. Installing drivers. The firmware of the test sketch. ATmega microcontroller-based control systems over low-voltage networks.

LIST OF REFERENCES

BASIC:

1. Lyashenko, A. A., Nazarenko, A. Yu. Programmable Logic Controllers (PLCs). Textbook. Moscow: Forum, 2023.

2. Sergeev, A. N., Chernov, I. A. Automation Using Siemens PLCs and Controllers from Other Manufacturers. St. Petersburg: BHV-Petersburg, 2022.

3. Egorov, V. P. PLC Technologies: Fundamentals, Programming, Application. Moscow: DMK Press, 2021.

4. Kovalev, I. V. Programmable Controllers in Process Automation Systems. Moscow: Academy, 2020.

5. Frank Petruzella, Programmable Logic Controllers. 5th Edition, McGraw-Hill, 2020.

6. Hugh Jack, Automating Manufacturing Systems with PLCs. 2021 (Open Source).

7. Jon Stenerson. Fundamentals of Programmable Logic Controllers, Sensors, and Communications. — Prentice Hall, 2020.

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8. Sokolov, Yu. A.. Building Control Systems Based on Direct Logic Controllers. — Moscow: Scientific and Technical Center of Electromechanics, 2019. — 82 p.

9. Morrisey, P.. Implementing BPL Technology // Communication Networks and Systems. — 2015. — No. 12. — pp. 79-81

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15. Pavlovsky A. Solomasov S. PLC in Russia. Specifics, problems, solutions, projects. // Inform courier communication. - 2013. - No. 8. - P. 29-33

16. Nevdyaev L.M. Bridge to the Internet via power lines. // Inform courier communication. - 2018. - No. 8. - P. 25-28

17. Konoplyansky D.K. PLC - data transmission over electrical networks. The last mile. // Inform courier communication. - 2004. - No. 5. - P. 5-7

18. Duffy D. BPL is gaining strength. // Networks. - 2015. - No. 14 - P. 24

4. Intelligent control and control systems

Topic 1 Intelligent automatic control systems.

Structure, models and algorithms of intelligent systems. ACS with associative memory. Fundamentals of phase management. Basic phase logic procedures for a fuzzy automatic control algorithm. Features of expert systems. The main elements of a typical expert system.

Topic 2 Neural network systems and regulators.

A model of an artificial neuron. Neural network training. Training a simple single-layer network. Neural networks of error backpropagation. Advantages and disadvantages of forward and reverse error propagation. The multilayer perceptron and its training. Retraining and generalization.

Topic 3 of the Hopfield Network.

Pattern recognition by Hopfield networks. Associative memory on Hopfield networks. Kohonen maps. Neural networks with self-learning. Self-study with competition. Image recognition by the Kohonen network.

Theme 4 of the ART-1 Network.

Architecture and operating principle of the ART-1 network. Neural network modeling environment. Fuzzy Logic neural networks. A fuzzy set, a transition point. Operations of addition, intersection, and union of fuzzy sets. The implication operation. Fuzzy and linguistic variables. Aggregation and simplified fuzzy inference algorithm. The algorithms of Tsukamoto and Mamdani.

Topic 5 Neuroprocessors based on DSPP and PLIC.

Neurocomputers implemented on the basis of DSPP. Neurocomputers implemented on the basis of PLICs. Comparative analysis of neurocomputers with different databases. Implementation of neural networks and neurocomputers.

Synthesis of parallel algorithms for information processing in intelligent dynamic systems in case of sudden disturbances.

LIST OF REFERENCES

BASIC:

1. Kasatkin, A. A., Smirnov, S. A., Intelligent Control Systems: Theory and Practice. Moscow: Goryachaya Liniya-Telecom, 2023.

2. Zade, A., Fuzzy Sets and Applications to Intelligent Control. Moscow: Mir, 2020 (reprint).

3. Kruk, A. B., Intelligent Control Systems Based on Neural Networks and Fuzzy Logic. St. Petersburg: Piter, 2021.

4. Alekseev, V. A., Machine Learning and Intelligent Control Systems. Moscow: DMK Press, 2022.

5. Kazuo Tanaka and Hua O. Wang, Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach. Wiley-IEEE Press, 2020.

6. S. Haykin, Neural Networks and Learning Machines. — 3rd Edition, Pearson, 2020.

7. Karray, A. O., Silva, C. A. Soft Computing and Intelligent Systems Design: Theory, Tools, and Applications. — Pearson, 2021.

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9. Devyatkov, V. V. Artificial Intelligence Systems. — Moscow: Bauman Moscow State Technical University, 2001, 352 p.

10. Intelligent Automatic Control Systems / Ed. by I. M. Makarov. — Moscow: Fizmatlit, 2001, 576 p.

11. Kadurin, A. A. Deep Learning. Immersion in the World of Neural Networks. – St. Petersburg: Piter, 2018. – 279 p.

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14. Tadeusevich R. An Elementary Introduction to Neural Network Technology with Program Examples. – Moscow: Goryachaya Liniya-Telecom, 2011. – 408 p.

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19. Bratko I. Programming in Prolog for Artificial Intelligence: Translated from English. – Moscow: Mir, 1990. – 387 p.