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ALMATY UNIVERSITY OF POWER ENGINEERING AND COMMUNICATIONS NAMED AFTER GUMARBEK DAUKEYEV

INSTITUTE OF TELECOMMUNICATIONS AND AUTOMATION

DEPARTMENT OF TELECOMMUNICATION ENGINEERING

I approve
Vice-Rector for Science
_____ K. Alipbaev
«___» _____ 2026

PROGRAM

entrance examination for doctoral studies in the field of 8D062 "Telecommunications"

8D06201 –Radio engineering, electronics and telecommunications

Almaty 2026

This program of the entrance examination for doctoral studies in the educational program 8D06201 - "Radio Engineering, Electronics and Telecommunications" is compiled on the basis of standard, working curricula and the working program of the discipline "Scientific and technical problems in Radio Engineering, Electronics and Telecommunications" of the master's degree program.

The program was reviewed and approved at the meeting of the Department of Telecommunication Engineering on May 13, 2026, protocol No. 9.

Head of the Department of TE _____ Kadylbekkyzy E.

The entrance exam program for OP 8D06201 - "Radio Engineering, Electronics and Telecommunications" was approved by the educational and methodological commission of the Institute of Telecommunications and Automation on "____" May 2025, protocol No. ____.

Director of ITA _____ Omarbekova AO

Entrance exam program for OP 8D06201 – "Radio Engineering, Electronics and Telecommunications" agreed with the Department of Science of the Gumarbek Daukeev AUPES.

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

Entrance exam program for OP 8D06201 – "Radio Engineering, Electronics and Telecommunications" agreed with the Department of Academic Affairs of the Gumarbek Daukeev AUPES.

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

I. General Provisions

1. The program has been compiled in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 600 "On approval of the Model Rules for admission to study in educational organizations implementing educational programs of higher and postgraduate education" (hereinafter referred to as the Model Rules), taking into account the amendments and additions made.

2. The entrance examination for doctoral studies includes an interview, essay writing, and an examination on the profile of a group of educational programs.

Block	Points
1. Interview	30
2. Essay	20
3. Examination according to the profile of the educational program group	50
Total/passable	100/75

3. The entrance exam lasts 3 hours and 10 minutes, during which applicants write an essay and respond to an electronic exam form. An interview is held at the university prior to the entrance exam.

II. Procedure for conducting the entrance examination

1. Applicants to doctoral studies in OP 8D06201 – "Radio Engineering, Electronics and Telecommunications" Write a problematic/thematic essay. The essay must be at least 250 words long.

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

Types of essays:

- a motivational essay disclosing the motives for research activities;
- a scientific and analytical essay justifying the relevance and methodology of the planned research;
- a problematic/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. The electronic examination ticket consists of 3 questions.

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Entrance exam program
in doctoral studies under the educational program
8D06201 - Radio Engineering, Electronics, and Telecommunications

Topic 1. Current state and development prospects in the field of radio engineering, electronics and telecommunications.

Classification of ground-based radio systems. Development trends of modern ground-based radio systems. The current state of space-based navigation and communication systems. Development challenges in direction finding and navigation systems. Prospects for the development of ground- and space-based navigation systems. Current trends in the development of audio and video transmission systems.

Topic 2. Current status and trends in radio engineering, electronics, and telecommunications

- Industry 4.0 and 5G/6G as drivers of industry development. Industry 4.0, the concept of digital transformation of production processes, the Internet of Things (IoT)/IIoT systems, their architecture and capabilities, big data, machine learning, and automation.
- Sustainable (green) telecommunications. Energy-efficient radio systems with automatic power management; Renewable power sources for base stations (solar, wind); Off-grid and hybrid-grid BTS for remote areas; Heat recovery from data centers and the use of liquid cooling; Smart traffic management (AI-based traffic steering) to reduce network load; Hybrid and software-defined radio systems (SDR), Development of satellite and quasi-satellite (HAPS) communication systems.

Topic 3. Distributed Computing and nanotechnology.

The concept of distributed computing. Grid network architecture.Web services inGRIDTypes of cloud computing. Cloud computing architecture.The concept of nanotechnology in electronics and telecommunications. Qualitative changes in the functioning of electronic components with the transition to the nanoscale. The main objectives and principles of nanoelectronics. Possible ways to create a nanoprocessor. Switches based on individual molecules. The development of nanoelectronics in the Republic of Kazakhstan and worldwide. Forecasts for the development of the element base of computing technology. "Moore's Law." The introduction of modern types of microprocessors and signal processors. Prospects for the development of signal processors and microcontrollers. Prospects for the use of nanotechnology in the field of recording and playback of information. Prospects for the use of nanotechnology in image reproduction systems.

Topic 4. Neural networks.

Neural networks: their origins and modern uses. Pattern recognition using neural networks. The formal neuron. Neural network architecture. The Hopfield neural network. The internet as an analog of a neural network, and other analogies to neural networks in nature and society.

Topic 5. Electromagnetic compatibility (EMC) of radio-electronic equipment.

Radio Monitoring Rules in the Republic of Kazakhstan. Electromagnetic Environment. EMC Analysis Methods. Electromagnetic Environment Research. Classification of Radio Interference by Origin and Method of Impact on Technical Equipment. Key Ways to Achieve EMC Standards. Types of EMC Testing of Technical Equipment: Interference Emission; Interference Immunity. EMC Requirements and Certification Testing.

Topic 6. Test methods for technical equipment and radio systems.

Standards, requirements and test methods for industrial radio interference; harmonic components of current consumed by technical equipment from the power supply network; voltage fluctuations and flicker caused by technical equipment in the power supply network. Classification of requirements for technical (TS) and radio systems to ensure operability under operating conditions. Classification of primary equipment for testing for electromagnetic compatibility. Basic requirements and test methods for TS immunity to various types of interference. Basic requirements and test methods for TS immunity to electrostatic charges and radio-frequency electromagnetic fields. Requirements and test methods for resistance to external influences and degrees of protection of cases (casings) of electronic equipment. Tests for different climatic regions. Categories, conditions of operation, storage and transportation of electronic equipment in terms of exposure to climatic factors of the external environment. Degrees of protection provided by casings (IP code). Vibration tests. Test methods for resistance to mechanical external influences.

Topic 7. Modern Optical Telecommunications: Trends and Breakthroughs

Optical technologies remain the foundation of the global telecommunications infrastructure, providing ultra-high-speed, reliable backbone, regional, and intra-regional data transmission. Several key development trends have emerged in recent years:

1. Next-generation coherent optics. Use of coherent receivers with QAM modulation up to 128-QAM and symbol rates exceeding 100 Gbaud. Implementation of DSP (digital signal processing) and AI/ML to compensate for nonlinear distortions and adapt to channels. Use of green technologies for more efficient use.

2. Optical transponders based on photonic integrated circuits (PICs). Integration of lasers, modulators, photodetectors, and filters into a single chip.

Reducing power consumption and device size. Widespread adoption of silicon photonics (SiPh) for data centers and backbones.

3. Free-space optical (FSO) and laser communications. Development of optical terminals for satellites and HAPS. High-speed communications (up to 10–100 Gbps) between buildings, UAVs, and satellites. Resistance to radio frequency interference and the ability to use in closed frequency bands.

4. Multicore and Few-mode optical fibers. Increased throughput through spatial multiplexing (SDM). Application in intercontinental backbones and data centers.

5. Development of next-generation PON networks (XGS-PON, NG-PON2)

Recommended reading:

Main:

1. International Electricity Commission (IEC) standards for resistance to external influences – IEC 68 series

2. International Electrical Commission standards for electromagnetic compatibility – IEC 61000 series

3. The 6G Vision – Latva-aho, M. et al. – Wiley, 2021

4. Digital Signal Processing: Principles, Algorithms, and Applications – Proakis, Manolakis – Pearson, 2022

5. Neural Networks and Deep Learning – Michael Nielsen (https://neuralnetworksanddeeplearning.com)

6. Video Compression and Communications – Wang, Zhu – Elsevier, 2020

7. Quantum Communication and Quantum Networking – Springer, 2021

8. Fundamentals of Electromagnetic Compatibility – Clayton R. Paul – Wiley, 2018

9. Smart Antennas and Signal Processing in 5G and Beyond – CRC Press, 2023

10. Nanotechnology for Telecommunications – Al-Muhtadi, Alsharif – Springer, 2020.

11. Gregory T. M., Thomas L. K., "Fiber Optic Telecommunications. Principles and Practice" - Moscow: Technosfera, 2021. ▪ A complete guide to the theory and practice of optical transmission systems. ▪ Includes modern approaches to coherent communication, modulations and WDM.

12. Kezel A. "Optical Communication Networks" – Moscow: Radio and Communications, 2020. ▪ Reveals the structure of fiber-optic lines, equipment, DWDM, CWDM, and PON technologies. ▪ Includes case studies and examples from providers' practices.

13. Shuvalov V. P., Fokin V. G. Long-range optical access networks. - M.: Goryachaya Liniya-Telecom, 2023. - 228 p. - ISBN 978-5-9912-0724-9.

14. Sillard P., "Multicore and Few-Mode Fiber Technologies" – Springer, 2019. Next-generation fibers for SDM (space division multiplexing) are described in detail. ▪ Relevant for backbone systems and 6G networks.

15. Ramaswami R., Sivarajan K. N., Sasaki G. H. "Optical Networks: A Practical Perspective", 4th ed. – Morgan Kaufmann, 2020. ▪ Practice of building

modern optical networks, including SDN, ASON, Flex-Grid. Parameter calculation, protection, routing and planning.

Additional:

1. Goldstein B.S., Kucheryavy A.E. Post-NGN communication networks. - St. Petersburg: BHV-Petersburg, 2013. -160 p.

2. Goldstein B.S., Sokolov N.A., Yanovsky G.G. Communication networks. – St. Petersburg: BHV-Petersburg, 2010. – 400 p.

3. Tikhvinsky V.O., Terentyev S.V., Yurchuk A.B. LTE mobile communication networks: technologies and architecture. – M.: eco-Trends, 2010. – 284 p.

4. Somov A.M., Kornev S.F. Satellite communication systems. – M.: Goryachaya Liniya-Telecom, 2012, - 244 p.

5. Golovin O.V. Radio receiving devices. - M.: Goryachaya Liniya-Telecom 2002.

6. Television edited by V.E. Dzhakonia. - M.: Radio and Communications, 2007

7. Artyushenko V.M., Sheloukhin O.I., Afonin M.Yu. Digital compression of video information and sound. - M.: Hot line: telecom, 2003. - 426 p.

8. Bykhovsky M.A. Development of Telecommunications. Towards an Information Society. Development of Satellite Telecommunication Systems: A Textbook for Universities. – Moscow: Goryachaya Liniya – Telecom, 2014. – 436 p.

9. Perov A.I. Fundamentals of constructing satellite radio navigation systems: Textbook for universities. – M.: Radio Engineering, 2012. – 240 p.

10. Methods of satellite and ground positioning. Prospects for the development of signal processing technologies / Ed. D. Dardari, E. Falletti, M. Luise. – Moscow: Tekhnosfera, 2012 – 528 p.

11. Dvorkovich V.P., Dvorkovich A.V. Digital video information systems (theory and practice). – M.: Tekhnosfera, 2012. – 1008 p.

12. Sheloukhin O.I., Guzeev A.V. Compression of audio and video information: Tutorial. – M.: MTUSiI, 2012. – 88 p.

13. Reese J. Cloud computing. - St. Petersburg: BHV-Petersburg, 2019. - 288 p.

14. Bykov R.E., Freyer R., Ivanov K.V., Mantsvetov A.A. Digital image transformation. Textbook for universities. -M.: Goryachaya Liniya-Telecom, 2012. – 228 p.

15. Petrakov A.V. Protective information technologies of audio-video telecommunications. – M.: Elektroatomizdat, 2010. – 616 p.

16. Ergozhin E.E., Aryn E.M., Suleimenov I.E., Belenko N.M., Gabrielyan O.A., Suleimenova K.I., Mun G.A. Nanotechnology. Economics. Geopolitics. / Library of nanotechnology. Almaty – Moscow-Sofia-Antipolis – Simferopol: Print-S LLP Publishing House, 2010. – 227 p.

17. Ibragimov I.M. Fundamentals of computer modeling of nanosystems. - St. Petersburg: Lan, 2010. - 384 p.

18. Shchuka A.A. Nanoelectronics. - M.: Binom, 2012. - 342 p.

19. Marder NS. Modern Telecommunications. - M.: IRIAS, 2006. - 384 s.

20. Foster L. Nanotechnology. Science, Innovation and Opportunities. Moscow: Tekhnosfera, 2008. – 352 p.

21. Martinez-Duarte J. Nanotechnologies for micro- and optoelectronics. – M.: Tekhnosfera, 2007. – 368 p.

22. Suleimenov I.E., Fedulina I.N., Kulikov A.A. Current state of radio engineering, electronics and telecommunications. Lecture notes for graduate students. – Almaty: AUES, 2016. – 106 p.

Internet resources:

23.

Electromagnetic compatibility of vehicles

28.

http://lib.tarsu.kz/rus/all.doc/Elektron_res/Riz_Oblachnie%20vichislenie.pdf

25. http://neuralnetworksanddeeplearning.comNeural networks and deep learning