

APPROVED
at a meeting of the
Scientific Council
NJSC «Al-Farabi KazNU».
Minutes No.10 dated
May 13, 2023.

The program of the entrance exam for applicants to the PhD
for the group of educational programs
D096 - «Information and communication technologies»

1. General provisions.

1. The program was drawn up 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 Education in Educational Organizations Implementing Educational Programs of Higher and Postgraduate Education” (hereinafter referred to as the Model Rules).

2. The entrance exam for doctoral studies consists of writing an essay, passing a test for readiness for doctoral studies (hereinafter referred to as TRDS), an exam in the profile of a group of educational programs and an interview.

Block	Points
1. Essay	10
2. Test for readiness for doctoral studies	30
3. Exam according to the profile of the group of the educational program	40
4. Interview	20
Total admission score	100/75

3. The duration of the entrance exam is 4 hours, during which the applicant writes an essay, passes a test for readiness for doctoral studies, and answers an electronic examination. The interview is conducted on the basis of the university before the entrance exam.

2. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D096 - «Information and communication technologies» write a problematic / thematic essay. The volume of the essay is at least 250-300 words.

2. The electronic examination card consists of 3 questions.

**Topics for exam preparation according to the profile of the group of
the educational program.**

Discipline "Digital Integrated Circuits"

Topic 1. Integrated circuits and MOS transistors.

Subtopics: Transient Processes and Some Spillovers on Diodes and MOSFETs. Programmable read-only memory. Digital devices based on multiplexers. JTAG. UART. Systems on a chip.

Topic 2. FPGA programming languages.

Subtopics: Verilog HDL, VHDL.

Topic 3. Design of digital devices.

Subtopics: Design of storage and matrix devices. Parallel and parallel pipeline methods of computing in FPGAs.

**Discipline "Scientific and technical problems of radio engineering, electronics and
telecommunications"**

Topic 1. Modern approach to the construction of telecommunication systems.

Subtopics: Analysis of modern approaches to the problem of routing digital signals. Bandwidth requirements for different types of services.

Topic 2. Structural analysis and synthesis of communication networks.

Subtopics: Communication network as a large system. A systematic approach to the analysis and synthesis of communication networks. Distribution of channels on networks. Methods for optimizing the structure of networks. Optimization of developing structures. Forecasting the main parameters of communication networks. Methods for statistical modeling of communication networks.

Topic 3. Processing of digital signals.

Subtopics: Pulse Code Modulation (PCM), Adaptive Delta Modulation (ADM), Adaptive Differential Pulse Code Modulation (ADPCM). Evaluation of immunity from quantization noise in linear and nonlinear coding. Sampling noise.

Topic 4. Principles of building optical multiservice transport networks.

Subtopics: TCP / IP technologies, ATM, etc. Principles of constructing clock network synchronization and distribution of clock synchronism in transport networks. Transport network management principles. Principles of protection of transport networks.

Discipline "Modern fiber-optic transmission systems"

Topic 1. Features of the construction of fiber-optic transmission systems (FOTS).

Subtopics: Methods for compaction of fiber-optic communication lines (FOCL). Main characteristics of active and passive components of FOTS and FOCL. Dispersion characteristics of multimode optical fibers.

Topic 2. Classification of fiber optic waveguides.

Subtopics: Stepped Fiber Optic Waveguides. Gradient Fiber Optic Waveguides. Material and waveguide dispersion.

Topic 3. Features of the use of modern single-mode Fiber Optic Waveguides.

Subtopics: Prospects for the development of single-mode communication lines. Scopes of multimode Fiber Optic Waveguides. Nonlinear effects in optical fibers.

Discipline "Modern wireless technologies"

Topic 1. Features of the architecture of modern wireless technologies.

Subtopics: Simplex and Duplex Wireless Technologies. Optical and radio wave wireless technologies. Operating principles and features of Bluetooth, RFID, ZigBee, NFC, LoWPAN, Wi-Fi, LoRa, WiMAX. Reception and transmission of data GSM, CDMA, TDMA. IoT technologies.

Topic 2. Broadband signals in communication systems.

Subtopics: Model of digital communication systems with broadband signals. Wideband digital signal processing, processing gain and noise immunity. Frequency hopping broadband signals. Correlation properties of wideband signals based on pseudo-random sequences and orthogonal codes. Synchronization in broadband digital communication systems.

Topic 3. Satellite communication and broadcasting systems.

Subtopics: Features of the propagation of radio waves in satellite telecommunication systems. The main frequency bands used in satellite communication systems. Multi-station access methods in satellite communication systems.

Topic 4. Antenna characteristics.

Subtopics: Field of two elementary radiators, far-field and near-field regions of an antenna, antenna directional pattern, antenna directivity, antenna polarization parameters, antenna classification. Fractal antennas, their power spectrum advantages.

Discipline "**Physical processes of nanoelectronics and optoelectronics**"

Topic 1. Electrical conductivity of semiconductors.

Subtopics: Classification of solid states by the energy spectrum of electrons in them; calculation of the concentration of charge carriers; electrical conductivity of its own semiconductors; doping with donor and acceptor impurities; electrical conductivity of doped crystals.

Topic 2. Non-equilibrium processes in semiconductors.

Subtopics: Recombination of Electrons and Holes; mechanisms of recombination of electrons and holes; diffusion and drift current in semiconductors; description of the behavior of the nonequilibrium momentum of charge carriers.

Topic 3. Electron-hole transition in semiconductors.

Subtopics: Potential Barrier; charge transport through the barrier; current-voltage characteristic of the p-n-junction; generation - recombination currents in the p-n-junction; barrier capacitance of the p-n-junction; diffusion capacity of the p-n-junction; transient processes in the p-n-junction; breakdown of the p-n junction.

Topic 4. Nanoelectronics.

Subtopics: Fields of Application of Quantum-Sized Structures (RS). The main advantages of devices based on RLS in comparison with classical semiconductor devices. Quantum-dimensional effects. Electronic structure, optical properties. The relationship between size and functionality. Modern electronic devices based on nanostructures.

3. List of references.

Main:

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