AL FARABI KAZAKH NATIONAL UNIVERSITY

Approved at the meeting of
Academic Committee (SMC)
Al Farabi KazNU
Vice Rector for Academic Affairs
_____A. K. Hikmetov
Protocol No. 6 dated June 22, 2020

PROGRAM
OF ENTRANCE EXAM FOR DOCTORS PhD IN EDUCATIONAL PROGRAM
"8D06201 -RADIO ENGINEERING, ELECTRONICS AND TELECOMMUNICATIONS"

ALMATY 2020

The program is compiled in accordance with the State general educational standard in the educational program "6D071900-Radio engineering, electronics and telecommunications".

The program was considered at the meeting. Department of Solid State Physics and Nonlinear Physics
Protocol No. ___ of "___" _____ 2020

Head of Department _____ M.K. Ibraimov

Approved at a meeting of the method bureau of the Faculty of Physics and Technology
Minutes No. ___ of "___" _____ 2020

Chairman of the method bureau _____ A.T. Gabdullina

Approved at the meeting of the Scientific Council
Minutes No. ___ of "___" _____ 2020

Chairman of the Scientific Council
Dean of the faculty _____ A.E. Davletov

Scientific Secretary_____ RU. Masheeva

CONTENT

1. Goals and objectives of the entrance exam in the educational program

The purpose of the entrance exam program is to identify the level of theoretical training of applicants for the doctoral program and formulate a personal recommendation for admission on the basis of competitive participation.

The entrance exam program includes disciplines of the compulsory component of the standard curriculum of the specialty 6D071900-Radio engineering, electronics and telecommunications GOSO RK 5.04.034-2009.

At the entrance exam, applicants for doctoral studies should show the depth of knowledge in the main disciplines of previous training, research potential that are sufficient and necessary for the successful completion of the educational program of doctoral training and the defense of a doctoral dissertation on the subject of the specialty.

An applicant must demonstrate the ability to work independently with contemporary literature, demonstrate his achievements in the field of contemporary radio engineering, electronics and telecommunications in the form of author publications, diplomas, certificates, etc.

The entrance exam form is a combined written exam. Examiners record their answers to questions on the exam ticket on the answer sheets. In the event of an appeal, the basis for consideration is the written records in the answer sheet.

2. Requirements for the level of training of applicants for PhD doctoral studies

The previous minimum level of education of persons wishing to master the educational doctoral programs in specialty 6D071900-Radio Engineering, Electronics and Telecommunications - DOCTOR

Entry requirements:

have an idea: the ability to critically analyze and evaluate contemporary scientific achievements, generate new ideas in solving research and practical problems.

know: methods of analysis of modern physical and technical problems, methods and methods for solving experimental and theoretical problems of electronics, electronic systems and telecommunications.

be able to: to analyze, systematize and generalize scientific and technical information on the topic of research

have: methods of systematization and presentation of the results of scientific work.

3. Prerequisites of the educational program

1. Nonlinear processes in electronic communication systems - 3 cr
2. Physical processes of nanoelectronics and optoelectronics- 3 cr
3. Scientific and technical problems of radio engineering, electronics and telecommunications-2 cr.

4. The list of exam topics

Discipline "Nonlinear processes in electronic communication systems"

1. General information about communication systems. Basic concepts and definitions. Stages of development of communication systems. The principles of building information transfer systems. Generalized structural schemes of information transmission systems. Characteristics of information transmission systems.

2. Classification of signals. Methods for their presentation. Fourier transform. Laplace transform. Correlation analysis of signals. Wavelet analysis of signals. Narrowband signals. Kotelnikov's theorem. Analytical signal and Hilbert transform. Correlation theory of random processes. Narrowband random processes. Rayleigh distribution. Rice distribution.

3. Fundamentals of the theory of random signals. Random processes. Impact of random signals on linear stationary systems. Continuous, discrete random processes. Methods for their description. Normal, Poisson and Markov processes. Correlation functions and energy spectra of typical messages and communication signals.

4. Methods of forming and converting signals. Signal modulation. Angular modulation methods. The formation and detection of modulated signals. Manipulation of signals.

5. Models of communication channels. Models of continuous communication channels. The passage of signals through channels with deterministic characteristics. Discrete communication channels. Discrete channel model without memory. Non-binary symmetrical channel. Models of error flows in discrete channels.

6. The main provisions of the theory of information. Entropy as a quantitative measure of the degree of uncertainty. Information characteristics of message sources. The concept of information. Information in a complex system.

7. Immunity to receive discrete messages. Quality criteria and rules for receiving discrete messages. Optimal demodulation for coherent signal reception. Immunity to receiving signals with known parameters. Reception of signals with an uncertain phase.

8. Noises. Characteristics of a random process. Autocorrelation function. Spectral density. The main types of noise. Thermal noise. Shot noise. Flicker noise. White noise. Noise conversion in linear circuits. Noise characteristics of devices.

9. Signal-to-noise ratios (SNR), information / entropy (IER), Detection algorithms. Signal extraction from noise.

10. Self-oscillating systems, structure and their application.

11. Logical elements and their radio engineering implementations.

References

Main literature:

1. Baskakov S. I. Radio engineering circuits and signals: Textbook for universities. 3rd ed., Revised. and add. - M.: Higher School, 2000.

2. Gonorovsky I. S. Radio engineering circuits and signals: Textbook for universities. - 5th ed., Rev. and add. - M.: Bustard, 2006.

3. M. T. Ivanov, A. B. Sergienko, V. N. Ushakov. Theoretical foundations of radio engineering: Textbook. allowance / Ed. V.N.Ushakova. - 2nd ed. - M .: Higher. school., 2008.306 s.

4. Bikkenin R.R., Chesnokov M.N. Theory of electrical communication / R.R. Bikkenin, M.N. Chesnokov. - M.: Academy, 2010 .-- 336 p.

5. Bernard Sklyar. "Digital communication. Theoretical foundations and practical application (2). " - 2003.

6. Yitzhoki, Y. S. Nonlinear radio engineering; M .: Soviet Radio, 2001. - 508 p

7. Zherebtsov, I.P. Radio engineering; M.: Communication, 2005 .-- 655 p

8. Golubeva, N.S. Fundamentals of ultra-high frequency electronics: Textbook / N.S. Golubeva, V.N. Mitrokhin; Under the total. ed. prof. Doctor of Technical Sciences I.B. Fedorov. - M.: MSTU. Bauman, 2008 .-- 488 p.

9. Gumenyuk, A.D. Fundamentals of Electronics, Radio Engineering and Communication: Textbook for High Schools / A.D. Gumenyuk. - M .: RiS, 2015 .-- 480 p.

10. Kaganov, V.I. Fundamentals of Radio Electronics and Communication: Textbook / V.I. Kaganov, V.K. Bityugov. - M .: GLT, 2014 .-- 542 p.

11. Phillips CL, Parr JM, Riskin EA Signals, systems, and transforms. - Prentice Hall, 2013.

12. Roberts MJ Fundamentals of signals and systems. - McGraw-Hill Science / Engineering / Math, 2007.

13. Kudeki E., Munson DC Analog signals and systems. - Pearson Prentice Hall, 2009.

Additional literature:

1. Manaev, E.I. Fundamentals of Radio Electronics / E.I. Manaev. - M .: LIBROCOM, 2013 .-- 512 p.

2. Martyushev, Yu.Yu. Fundamentals of Radio Electronics / Yu. Yu. Martyushev, N.P. Nikitina, G.D. Petrukhin. - M.: University Book, 2009. - 416 p.

3. Nefedov, V.I. Fundamentals of radio electronics and communications. / IN AND. Nefedov. - M.: Higher School, 2009. - 735 p.

4. Glushkov V.A., Nesterenko A.G. Theory of electrical communication. Part 1. Discrete signals. Tutorial. Ulyanovsk: UFVUS, 2003 .-- 96 p.

5. Glushkov V. A., Nesterenko A. G., Popov N. A. Theory of electrical communication. Tutorial. Part 2. Immunity. - Ulyanovsk: UVVIUS, 2007 .—78p.

6. Zhanabaev Z. Zh., Tarasov S. B., Turmukhambetov A. Zh. Fractaly. Information. Turbulence.- Almaty: RIO VAK RK, 2000.

7. Zhanabaev Z. J., Tarasov S. B., Almasbekov N.E. Statistical methods of radiophysics and electronics. –Almaty, 2002.

8. Thomasi, W. Electronic communication systems / W. Thomasi. - M .: Technosphere, 2007 .-- 1360 p.

9. Skyrms B. Signals: Evolution, learning, and information. - Oxford University Press, 2010.

10. Karrenberg U. Signals, processes, and systems: an interactive multimedia introduction to signal processing. - Springer Publishing Company, Incorporated, 2013.

11. Cook C. Radar signals: An introduction to theory and application. - Elsevier, 2012.

Discipline "Physical processes of nanoelectronics and optoelectronics"

1. The electrical conductivity of semiconductors. Classification of solids by the energy spectrum of electrons in them; calculation of the concentration of charge carriers; electrical conductivity of own semiconductors; doping with donor and acceptor impurities; electrical conductivity of doped crystals.

2. Nonequilibrium processes in semiconductors. Recombination of electrons and holes; recombination mechanisms of electrons and holes; diffusion and drift current in semiconductors; description of the behavior of the nonequilibrium momentum of charge carriers.

3. Electron-hole transition (p-n - transition) potential barrier; charge transport through the barrier; current-voltage characteristic of the p-n junction; generation - recombination currents in the p-n junction; p-n junction barrier capacitance; diffusion capacity of the p-n junction; transients in the p-n junction; breakdown of the p-n junction;

4. Nanoelectronics. Areas of application of quantum-dimensional structures (QDS). The main advantages of cattle-based devices in comparison with classical semiconductor devices. Quantum-size effects. Electronic structure, optical properties. Relationship of sizes with functionality.

5. Devices on resonant tunneling (diodes on resonant tunneling, transistors on resonant

tunneling, logic elements on resonant tunneling devices).

6. Radiative and spectral characteristics of optoelectronic systems. The propagation of light in anisotropic media. Dispersion. Optical transitions in semiconductors.

7. Physical principles of optical radiation. Photoelectric phenomena. Radiative and spectral characteristics. Internal photoelectric effect in semiconductors. Metrological foundations of optoelectronics

8. The principle of operation of lasers. Excitation of the active substance is pumping. Optical resonators. Different types of resonators. Confocal resonator. The self-excitation condition of the generator and the threshold pump energy. Saturation gain. Single-mode and multi-mode generation. Giant impulses. Mode synchronization and ultrashort light pulses.

9. Photodetectors for optical transmission systems. Requirements for optical radiation receivers. Definition of a photo detector. Types of photo detectors. Photodiodes. Designs, principle of operation, basic characteristics. Direct detection photodetectors. Reception optical modules. Photodetector detection devices with conversion. Estimation of the signal-to-noise ratio at the output of the photodetector. Noises of photodiodes. Equivalent noise photodiode circuit.

10. Dispersion and other characteristics of optical fiber (OV). General loss function, Rayleigh scattering, absorption of impurities, loss on bends and macroinhomogeneities; signal distortion characteristics (dispersion, dispersion compensation methods).

11. Measurement of optical power, attenuation and insertion loss. The principle of operation and the main characteristics of optical power meters; optical output power measurement; measurement of attenuation by clipping method, method of insertion loss; measurement of transient attenuation of an optical cable; general method for measuring insertion loss of optical elements; design, principle of operation, scope of optical reflectometers.

References

Main literature:

1. Sklyarov, O.K. Fiber-optic networks and communication systems: Textbook / O.K. Sklyarov. - St. Petersburg: Doe, 2010 .-- 272 p.

2. Ossovskaya, M.P. Fiber-optic networks and communication systems: TextbookKPT / M.P. Ossovskaya. - SPb .: Doe KPT, 2016 .-- 272 p

3. Physico-chemical fundamentals of integrated micro- and nanotechnology: a textbook for universities in 2 volumes, ed. Yu.N. Korkishko, T.1. Yu.D. Chistyakov, Yu.P. Rainova. Physicochemical fundamentals of microelectronics technology, M.: Binom, 2009

4. Physico-chemical foundations of integrated micro- and nanotechnology: a textbook for universities in 2 volumes, ed. Yu.N. Korkishko, M.V. Akulenok, V.M. Andreev, D.G. Gromov and others. Technological aspects, M.: Binom, 2010

5. Schuka A.A. Nanoelectronics.-M.: Fizmatlit, 2007.-464p

6.Dragunov V.P., Unknown I.G., Gridchin V.A. Fundamentals of Nanoelectronics: Textbook. 2 editions and supplementary Novosibirsk: Publishing House of NSTU, 2004.-496p

7. Vorobyov L.E., Ivchenko E.L., Firsov D.A., Shalygin V.A. Optical properties of nanostructures. Uch.posobie-SPb: Publishing House of Science, 2001 – 188p

8. Demikhovsky V.Ya., Vugalter. Physicist of quantum low-dimensional structures. M .: Logos, 2000

9. Pikhtin A.N. Optical and quantum electronics., Textbook. - M., "Higher School", 2012

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11. Ishanin G.G. Radiation receivers, textbook for universities - St. Petersburg, Papyrus, 2003

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13. Jha NK, Chen D. (ed.). Nanoelectronic circuit design. - Springer Science & Business Media, 2010.

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15. Korkin A., Rosei F. (ed.). Nanoelectronics and photonics: from atoms to materials, devices, and architectures. - Springer Science & Business Media, 2008.

16. Udd E., Spillman Jr WB (ed.). Fiber optic sensors: an introduction for engineers and scientists. - John Wiley & Sons, 2011.

Additional literature:

1. Tarasov S.A., Pikhtin A.N. Semiconductor optoelectronic devices, a training manual - St. Petersburg, Ed. LETI, 2008

2. Ignatov, A.N. Microcircuitry and nanoelectronics: Textbook / A.N. Ignatov. - St. Petersburg: Doe, 2011 .-- 528 p.

3. Ignatov, A. N. Classical Electronics and Nanoelectronics / A.N. Ignatov, N.E. Fadeev, V.L. Savinykh. - M .: Flint, 2009 .-- 728 p

4. Shishkin, G.G. Nanoelectronics. Elements, devices, devices: Textbook / G.G. Shishkin, I.M. Ageev. - M .: BINOM. Laboratory of Knowledge, 2011. - 408 p.

5. Bystrov, Yu.A. Optoelectronic devices and devices: textbook / Yu.A. Bystrov. - M.: Radio and Communications, 2001. - 256 p.

6. Ignatov, A.N. Optoelectronic devices and devices / A.N. Ignatov. - M .: Eco-Trends, 2006 .-- 272 p.

7. Gurtov, V.A. Solid State Electronics: Textbook / V.A. Hurts. - M .: Technosphere, 2007 .-- 408 p.

8. Ismail R., Ahmadi MT, Anwar S. Advanced nanoelectronics. - CRC Press, 2016.

9. Seideman T. (ed.). Current-driven phenomena in nanoelectronics. - CRC Press, 2016.

10. Kaul AB (ed.). Microelectronics to Nanoelectronics: Materials, Devices & Manufacturability. - CRC Press, 2017.

11. Chomycz B. Planning fiber optics networks. - McGraw-Hill Education Group, 2009.

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

1. A contemporary approach to the construction of telecommunication systems. Analysis of contemporary approaches to the problem of routing digital signals. Bandwidth requirements for various types of service.
2. Structural analysis and synthesis of communication networks. Communication network as a big system. A systematic approach to the analysis and synthesis of communication networks. Distribution of channels on networks. Network structure optimization methods. Optimization of developing structures. Prediction of the main parameters of communication networks. Methods of statistical modeling of communication networks.
3. Features of the formation of digital signals using pulse-code modulation (PCM), adaptive delta modulation (ADM), adaptive differential pulse-code modulation (ADPCM). Assessment of protection against quantization noise in linear and nonlinear coding. Noise sampling.
4. The principles of organization and rationing of the main characteristics of digital channels and paths. The organization of digital linear paths (DLP). Calculation and regulation of interference and distortion in digital channels and paths. Features of the formation and basic characteristics of codes in the DLP. Layered codes.
5. Features of the construction of fiber optic transmission systems (FOTS). Methods of sealing fiber-optic communication lines (FOCL). The main characteristics of active and passive components of FOTS and fiber optic links.
6. The principles of building optical multiservice transport networks based on technologies: TCP / IP, ATM, etc. The principles of building clock network synchronization and the distribution

of clock synchronism in transport networks. Principles of transport network management. Principles of protection of transport networks.

7. Ways to increase the noise immunity of telecommunication systems with moving objects. Types of transmission and control channels, their organization and functioning. Interaction with public networks.

8. Broadband signals in communication systems. Model of digital communication systems with broadband signals. Broadband signals with direct spreading of the spectrum, gain in processing and noise immunity. Broadband jumps. Correlation properties of broadband signals based on pseudo-random sequences and orthogonal codes. Synchronization in broadband digital communication systems.

9. Satellite communications and broadcasting systems. Features of the propagation of radio waves in satellite telecommunication systems. The main frequency ranges used in satellite communications systems. Multiple access methods in satellite communications systems.

10. Antenna characteristics: field of two elementary emitters, far and near zones of the antenna, antenna radiation pattern, antenna directivity, antenna polarization parameters, antenna classification. Fractal antennas, their advantages in power spectrum.

References

Main literature:

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2. Grebeshkov, A.Yu. Computers, networks and telecommunications .: Textbook for universities. / A.Yu. Grebeshkov. - M .: GLT, 2016 .-- 190 p.

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4. Crook, B.I. Telecommunication systems and networks: Textbook B 3 т. T. 1. - Modern technologies / B.I. Kruk, V.N. Popantonopulo. - M .: GLT, 2013 .-- 620 p.

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8. Borisov, V. I. Interference immunity of radio communication systems. Probability-time approach / V.I. Borisov, V.M. Zinchuk. - M.: RadioSoft, 2009. - 260 p.

9. Mashbits, L. M. Service areas for satellite communications systems / L. M. Mashbits. - M .: Radio and communications, 2012. - 168 p.

10. Agrawal GP Fiber-optic communication systems. - John Wiley & Sons, 2012 .-- T. 222.

11. Miller S. (ed.). Optical fiber telecommunications. - Elsevier, 2012.

12. Pahlavan K., Krishnamurthy P. Principles of wireless networks: A unified approach. - Prentice Hall PTR, 2011.

13. Goldsmith A. Wireless communications. - Cambridge University Press, 2005.

14. Tse D., Viswanath P. Fundamentals of wireless communication. - Cambridge University Press, 2005.

Additional literature:

1. Frolov, O. P. Mirror antennas for earth stations in satellite communications / O.P. Frolov, V.P. Wald. - M .: Hot line - Telecom, 2008 .-- 496 p.

2. Mizilov, V.F. Space Communication Systems: Textbook / V.F. Mizilov, .N. Moshkin, I.V. Bragin. - SPb .: SUAI, 2012 .-- 174 p.

3. Somov, A. M. Satellite communication systems / A.M. Somov, S.F. Kornev. - M .: GLT, 2012 .-- 244 p.

4. Vesolovsky, K. Mobile radio communication systems / K. Vesolovsky. - M .: GLT, 2006 .-- 536 p.

5. Komashinsky, V.I. Mobile radio communication systems with packet information transfer / V.I. Komashinsky. - M .: GLT, 2007 .-- 176 p.

6. Microwave devices and antennas, ed. DI. Voskresensky. - M .: Radio engineering, 2006.

7. Cameron RJ, Kudsia CM, Mansour R. Microwave filters for communication systems. - John Wiley & Sons, 2015.

8. Zheng J., Jamalipour A. Wireless sensor networks: a networking perspective. - John Wiley & Sons, 2009.

9. Friedland B. Control system design: an introduction to state-space methods. - Courier Corporation, 2012.

10. Korowajczuk L. LTE, WiMAX and WLAN network design, optimization and performance analysis. - John Wiley & Sons, 2011.

5. Scale for assessing the results of an examination in the educational program of doctoral studies

"8D06201 -RADIO ENGINEERING, ELECTRONICS AND TELECOMMUNICATIONS"

Letter Grade	The digital equivalent of points	% content	Traditional system assessment	Competency Scale
AND	4.0	95-100	Excellent	"Excellent" mark - deep comprehensive knowledge of all program material, understanding of the essence and interconnection of the processes and phenomena under consideration, solid knowledge of the main provisions of the disciplines: logically consistent, informative, complete correct and specific answers to all questions of the examination ticket and additional questions of members of the examination committee; use, to the extent possible, in answering questions of materials from all the recommended literature.
AND-	3.67	90-94		
B +	3.33	85-89	Good	Evaluation of "good" - solid and fairly complete knowledge of all program material, a correct understanding of the nature and relationship of the processes and phenomena under consideration; consistent, correct, specific answers to the questions posed with the free elimination of comments on individual issues.
IN	3.0	80-84		
IN-	2.67	75-79		
	2.00	50-74	satisfactorily	Assessment "satisfactory" - a solid knowledge and understanding of the main questions of the program, correct and specific answers, without gross errors, to the questions posed while eliminating inaccuracies and insignificant errors in highlighting certain provisions in leading questions of examiners, when answering questions the main recommended literature is not used enough.
		0-50	unsatisfactor y	The rating "unsatisfactory" is an incorrect answer to at least one of the

				main questions, gross errors in the answer, a misunderstanding of the essence of the questions posed; uncertain and inaccurate answers to additional questions