

**KAZAKH NATIONAL UNIVERSITY NAMED AFTER AL-FARABI  
FACULTY OF INFORMATION TECHNOLOGY**

Approved at the meeting  
Scientific and Methodological Council  
KazNU named after al-Farabi  
protocol No. \_\_\_\_\_  
from " \_\_\_\_\_ " \_\_\_\_\_ 2020

**PROGRAM  
ENTRANCE EXAM  
FOR APPLICANTS ON PHD BY SPECIALTY  
"8D07116 - INTELLIGENT CONTROL SYSTEMS"  
(for 3 year studies)**

**ALMATY 2020**

The program is compiled in accordance with the State educational standard in the specialty "8D07116 - Intelligent control systems." The program was compiled by Doctor of Technical Sciences, Professor B. Belgibaev, Ph.D., Associate Professor Volobueva O.P., Senior Lecturer Sakypbekova M.Zh.

The program was considered at a meeting of the Department of Artificial Intelligence and Big Data  
Minutes No. 28 April 14, 2020

Head Department \_\_\_\_\_ M.E. Mansurova

Approved at a meeting of the Methodological Bureau of the Faculty of Information Technology  
Minutes No. 8 of April 21, 2020

Chairman of the method bureau \_\_\_\_\_ F. Gusmanova

Approved at the meeting of the Scientific Council  
Minutes No. 10 of April 24, 2020

Chairman of the Scientific Council  
Dean of the faculty \_\_\_\_\_ B.A. Urmashev

Scientific Secretary \_\_\_\_\_ A.K. Sambetbaeva

## PROGRAM CONTENT

### 1. Goals and objectives of the entrance exam in the specialty

#### 1.1. The purpose of the entrance exam in the specialty

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

The entrance exam program includes the disciplines: “Industrial Automation and control”, “Introduction to intelligent control systems”, “Automated management on microcontrollers”

#### 1.2. Tasks of the entrance exam in the specialty

During the exam revealed:

- Knowledge of the applicant the fundamental principles of automation and control, information technology; main achievements and development trends of modern computer science; technologies of professional and scientific activity; knowledge of the main provisions of professional and scientific ethics and their use in work; knowledge of at least one foreign language at the level of fluency in the language of the specialty; knowledge of the basics of pedagogy and psychology; knowledge of the basics of management and the motivation of the scientific activities of the team.

- Ability to find, analyze and process scientific, technical, natural science and general scientific information, leading it to a problem-task form; publicly present their own new scientific results; to design and carry out their professional, scientific and scientific-pedagogical activities, as well as the activities of the team; be able to conduct joint scientific activities; to design your further professional development.

- Skills of independent research work and research work, as well as activities within the group; scientific project activities, the solution of standard scientific and professional tasks, the correct and logical design of their thoughts in oral and written form, the teaching of computer science in secondary specialized and higher educational institutions.

### 2. Requirements for the level of training of people entering PhD doctoral studies

Requirements for the level of training entering the doctoral program.

Previous level of education:

academic master's degree in the field of:

6M70200 - Automation and control

6M060200 - Informatics

6M070400 - Computer Engineering and Software

6M070300- Information Systems

6M100200-Information Security Systems

6M070500 –Mathematical and computer simulation

6M60100 - Mathematics

6M060300 - Mechanics

6M071800 - Electric power industry

6M060400 - Physics

6M071700 - Thermal power

6M072300 –Technical physics

6M060500 –Nuclear Physics

6M074600 –Space technology and technology

6M071900 - Radio engineering, electronics and telecommunications

Applicant must have a state document of the appropriate level of education.

The program of entrance exam for applicants for doctoral studies in the direction of preparation "8D07116 - Intelligent Control Systems" was developed at the Department of Artificial Intelligence and Big Data.

### **3. Prerequisites of the educational program**

The previous level of education of people wishing to master the educational doctoral programs is higher or postgraduate education in the specialties: 6M070200 - Automation and management; 6M070300 - Information systems; 6M060200 - Informatics; 6M070200 - Mathematical and computer modeling; 6M070400 - Computer engineering and software, etc.

Prerequisites:

Industrial Automation and control

Introduction to intelligent control systems

Automated management on microcontrollers.

### **4. The list of exam topics**

#### **1. Discipline " Industrial Automation and control "**

1. Option for the classification of technical automatic control systems (ACS).
2. Means of automation and control.
3. The equations of dynamics. Typical dynamic links.
4. The mathematical description of self-propelled guns in the state space. Linearization.
5. Stability of dynamical systems according to Lyapunov. Lyapunov theorems in a first approximation (first Lyapunov method).
6. The direct (second) Lyapunov method for determining the stability of self-propelled guns.
7. Construction of the Lyapunov function for linear systems.
8. The concept of managed objects. Manageability criteria for Kalman and Hilbert.
9. Observability of dynamical systems. Observational criteria for Kalman and Hilbert.
10. Criteria for the quality of regulation. A direct method for assessing the quality of regulation.
11. On the main directions in the theory of optimal processes.
12. Criteria for optimality of management.
13. Linear systems, optimal in speed. The Pontryagin maximum principle. Feldbaum's n-interval theorem.
14. The principle of Bellman optimality. Obtaining the functional Bellman equation. The connection of the dynamic programming method with the Lyapunov function.
15. Analytical design of the optimal controller (AKOR).

#### **Main literature:**

1. Fundamentals of the theory of automatic regulation and control // ed. Voronova A.A. - M.: Higher School, 1972. - 313 p.
2. Solodovnikov VV et al. Fundamentals of the theory and elements of automatic control systems. - M.: Mechanical Engineering, 1985. -- 535 p.
3. Collection of tasks on TAP and management // ed. Besekersky V.A. - M.: Nauka, 1978.- 510 p.
4. Topcheev Yu.I., Tsyplyakov A.P. Task book on TAP. - M.: Mechanical Engineering, 1977. -- 592 p.
5. Volobueva O.P. Fundamentals of control theory: a Textbook. - Almaty: Association of Universities of the Republic of Kazakhstan (KazNTU), 2005. - 255 p.
6. Volobueva O.P. Fundamentals of control theory: Textbook, 2nd edition., Revised. and add. - Almaty: KazNTU, 2015. -- 308 p.

7. Volobueva O.P. The study of the dynamics of self-propelled guns: a Training manual. - Almaty: KazNTU, 1999. - 86 p.
8. Kwakernaak H., Sivan R. Linear optimal control systems. - New York, Wiley-Interscience, 1972. Quakernaak H., Sivan R. Linear optimal control systems. - M.: Mir, 1977.
9. Pupkov K.A., Egupov N.D. et al. Methods of the classical and modern theory of automatic control. Volume 1-3. -M. : Nauka, 2010.

#### **Additional literature:**

1. Bellman R. Introduction to Matrix Analysis. - New York: McGraw-Hill Book Company, 1973. - 327 p.
2. Bellman R. Methods of Nonlinear Analysis. - New York: Academic Press, 1973. - 261 p.
3. Tsytkin Ya. Z. Fundamentals of the theory of automatic systems. - M. : Nauka, 1977. -- 559 p.
4. Besekersky V.A. Automatic control systems with micro-computers. - M. : Nauka, 1987. -- 318 p.
5. Isermann R. Digital control systems. Heidelberg - New York. 1981.
6. Iserman R. Digital control systems. - M. : Mir, 1984. - 541s.

### **2. Discipline "Introduction to intelligent control systems"**

1. The concept of neurocybernetics in ISU.
2. The main components of neural networks in the ISU.
3. The rule of signal propagation in the neural network of the ISU.
4. Areas of application of neural networks in the ISU.
5. The perceptron. Activation functions.
6. Training of neural networks.
7. Algorithm of back propagation of error.
8. Education with and without a teacher.
9. Gradient teaching methods.
10. ISU heuristic algorithms for training a neural network.
11. The use of a neural network to study the relationships and forecasting in the ISU. Neural automatic control systems
12. Neural networks of Hopfield.
13. Bidirectional associative memory.
14. Associative backward propagation of errors.
15. Neural networks - map of Kohonen.
16. The use of Kohonen maps in classification problems.
17. The genetic algorithm. Basic definitions, genetic operations.
18. The structure of the source data in solving problems of optimization and training of neural networks.
19. Genetic algorithm for solving multicriteria optimization problems
20. The implementation of neural networks in the environment of MatLab. NeuralNetworkToolBox package. Using MatLab environment functions for building and training neural networks.
21. Layer initialization functions. Functions for analysis. Deviation functions.
22. Educational functions of displacement and gradient descent. Habb function.

#### **Main literature:**

1. Gavrilova T.A., Khoroshevsky V.F. Knowledge base of intelligent systems. - St. Petersburg: Peter, 2000.

2. Devyatkov VV Artificial Intelligence Systems - M.: Publishing House of MSTU. N.E.Bauman, 2001
3. Luger, J. F. Artificial Intelligence: Strategies and Methods for Solving Complex Problems, 4th Edition: Per. from English M.: "Williams", 2003.
4. Safonov V.O. Expert systems - intellectual assistants of socialists; The island of "Knowledge", St. Petersburg - St. Petersburg, 1992.31s.
5. Gavrilova T.A. The knowledge base of intelligent systems: a manual for std. Universities - St. Petersburg: Peter, 2000 - 328 p.

#### **Additional literature:**

1. Potemkin V.G. Computations in MATLAB. M.: Dialog-MEPHI. 2004.
2. Grishchenko A.Z. Automated process control systems - K.: Technics, 1983
3. Peter Marwedel, Embedded System Design, Embedded Systems Foundations of CyberPhysical Systems, 2nd Edition, 2011
4. Alexandru Andrei, Dissertation, Energy Efficient and Predictable Design of Real-Time Embedded Systems, 2007, Department of Computer and Information Science, Linköping University, Sweden.
5. Masahiro Fujita, Indradeep Ghosh, and Mukul Prasad, VERIFICATION TECHNIQUES FOR SYSTEM-LEVEL DESIGN, 2008.
6. Gabriela Nicolescu .. Pieter J. Mosterman, Model-Based Design for Embedded Systems, 2010

#### **3. Discipline " Automated management on microcontrollers "**

1. Automated control systems (ACS) and microcontrollers. The history of the development of ACS.
2. The lower level of ACS on MK. Sub-level of sensors and actuators: purpose technical means.
3. Measuring instruments, relay voltage converters and their classification according to the type of output signal
4. Contact sensors. The main types of actuators. Sub-level of data collection by sensors and their interfacing with MK.
5. Interface devices, regulators and industrial controllers: purpose and technical characteristics.
6. Interface devices with the object. Purpose and structure
7. External connections of the controller with a PC using the example of Arduino and the Siemens S7 series and the creation of a pairing device for specialized controllers of ACS parameters.
8. Exchange of PC information with MK
9. Features of battery life MK and methods of transmitting text information on the screen MK
10. Programmable controllers: purpose, classification, structure and their interface. The modular principle of controller construction.
11. Modules of the central processor, power supplies, signal, communication processors, functional, interface (interfacing on the example of Siemens controllers).
12. Criteria for choosing an industrial controller for voltage, processor type and inputs / outputs for the design of ACS for the food industry.
13. Connection options for industrial controllers as part of ISUTP. Embedded Systems and Their Features
14. Indicators of quality and reliability of ACS.
15. Automated workplaces of technologists-operators of industrial production.

#### **Main literature:**

1. Petrov I.V. Programmable Controllers. .standard languages and techniques of applied design / Ed. prof. V.P. Dyakonova. - M .: SOLON-Press, 2004. -256s.
2. Parr E. Programmable Controllers: A Manual for an Engineer / Per. from English - M .: BINOM. Laboratory of Knowledge, 2007. -516s
3. Evans B. Beginning Arduino Programming.- Apress, 2011.-272 p.
4. Petin A. A. Projects using the Arduino controller. 2 ed. - B HV-Petersburg, 2015 .-- 464c.
- 5 Kopesbaeva A.A., Ibrasheva A.T. Microprocessor tools in the control system / Methodological instructions for laboratory work for students of the specialty 050702 - Automation and Controls - Almaty: AEC, 2007. - p.52

#### **Additional literature:**

1. Tubbs S. Programmable Logic Controller (PLC) Tutorial, Siemens Simatic S7-1200: Circuits and Programs for Siemens Simatic S7-200 Programmable Controllers. - Stephen P. Tubbs, 2007.- 140p.
2. Bolton W. Programmable Logic Controllers.- Newnes, 2015.- 424p

### **EXAM RESULTS EVALUATION SCALE**

The answer is evaluated at **“90+”** when it gives a complete and accurate answer to the question, demonstrates fluency in terms and concepts, contains a consistent and logical presentation, as well as completed conclusions and generalizations on the topic.

The answer is evaluated at **“75-89”**, when it gives a complete and accurate answer to the question, demonstrates knowledge of the basic terms and concepts, contains completed conclusions and generalizations on the topic.

The answer is evaluated at **“60-75”**, when it gives a complete and accurate answer to the question, demonstrates knowledge of basic terms and concepts, contains sufficient conclusions and some generalizations on the topic.

The answer is evaluated at **“50-60”**, when it gives a complete and accurate answer to the question, demonstrates satisfactory knowledge of the basic terms and concepts, satisfactory knowledge and knowledge of methods and means of solving problems, contains insufficiently consistent presentation of the material, as well as individual conclusions and generalizations on the topic .

The answer is rated at **"0-50"** when the lack of a complete and accurate answer to the question.