APPROVED
at a meeting of the Scientific Council
NJSC «Al-Farabi KazNU».
Minutes № ___ dated _____ .

The program of the entrance exam for applicants to the PhD for the group of educational programs D100 – «Automation and control»

I. 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, an exam in the profile of a group of educational programs and an interview.

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

3. The duration of the entrance exam is 3 hours 10 minutes, during which the applicant writes an essay and answers an electronic examination. The interview is conducted on the basis of the university before the entrance exam.

II. Procedure for the entrance examination

1. Applicants for doctoral studies in the group of educational programs D100 – «Automation and control» write a problem / thematic essay. The volume of the essay is at least 250 words.

The purpose of the essay is to determine the level of analytical and creative abilities expressed in the ability to build their own argumentation on the basis of theoretical knowledge, social and personal experience.

Types of essays:

- motivational essay with disclosure of motivations for research activity;
- scientific-analytical essay with justification of the relevance and methodology of the planned research;
- problem/thematic essay reflecting various aspects of scientific knowledge in the subject area.

Essay topics:

1. Intelligent control systems as a stage in the development of automated control systems
2. Problems of intellectualization of IoT devices
3. The use of IoT devices and artificial intelligence in the future

4. Control systems in IoT devices: current state and perspectives
5. Artificial intelligence: deterministic and non-deterministic approaches
6. Features of designing neural networks for automatic control tasks
7. Industry 4.0: main features on the example of Kazakhstan
8. Digitalization as a step towards Industry 4.0
9. Problems of data transfer between IoT devices, data transfer security
10. Problems of collective interaction of IoT devices in a wireless environment

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 "Mathematical methods in intelligent control systems"

Neurons and artificial neural networks. Classification of neural networks. Neural network architecture. Types of multilayer neural networks. Feedback networks. Formal neuron. Neuron activation function and its functions. Neural network training. Deep learning methods. Widrow- Hoff is teaching rule. Algorithm for training a single-layer neural network. Multilayer neural network. Algorithm for training a multilayer neural network. Learning with and without a teacher. The concept of "Artificial intelligence". Modern research areas in artificial intelligence. Technology for working with expert systems. Control object of an intelligent system. Tasks of control theory. General optimal control problem and its mathematical model. The role of the theory of optimal processes in solving technical problems. Necessary and sufficient conditions in the theory of optimal processes. The problem of the existence of optimal controls. The main problems of the theory of optimal processes. Positive manageability. Relative manageability. Conditional manageability. Lyapunov stability of dynamical systems. Lyapunov's theorems in the first approximation (Lyapunov's first method). Equilibrium position of two-dimensional linear systems. Methods of functional analysis in the Kalman observability theory. Pontryagin's maximum principle. The principle of optimality of dynamic programming (Bellman). Construction of the Lyapunov function for linear systems. Functional. Management quality criterion.

Discipline "Models of machine-to-machine interaction"

Discrete technological processes. Combinational deterministic ISC models. Technical means of data collection in IoT devices. Measuring transducers and their classification. Contact sensors and contact sensors for microcontrollers. Grassroots automation in multilevel IOT devices. Features of interface devices with the automation object. the role and place of microcontrollers in IoT devices. The role and place of industrial controllers in IoT devices. Methods for processing analog signals in IoT devices. IoT transmitting and receiving devices. The use of analog-to-digital and digital-to-analog converters in IoT devices. Normalizing converters in IoT devices. Discrete signal processing. Ethernet bus connection Software on the example of microcontrollers for IoT. Data exchange through external connections of the controller with a PC. Purpose, classification and structure of the microprocessor controller. Microcontroller architectures for IoT. Specialized automatic regulators. Programmable logic microcontrollers. Freely programmable controllers. Remote control from a mobile phone over the Internet by smart industrial and household intelligent systems. The concept of machine-to-machine interaction of smart IoT devices. The Comprehensive Internet - The Internet of Things. Development of smart technology and space technologies for wireless Internet IoT devices based on microcontrollers of the AVR and ESP32 series. IoT devices in industry, healthcare and home appliances. Micro-automation integrated environments. Arduino IDE for

IoT design based on AVR and ESP32 microcontrollers. Local server based on ESP32. Stepper motors and servos. PWM regulation of analog signals in microcontrollers. Graphical programming environment FBD and LAD for microcontrollers. Human machine interfaces (HMI) for microcontrollers.

Discipline "Safety in intelligent control systems"

Biometric system and its functions. Biometric characteristics and their properties. Ways and methods of identity authentication. Biometric authentication systems. Basic requirements for biometric systems. Biometric identification. Biometric registration. Biometric security. Secure authentication protocols. Access control in biometric systems. Fingerprint readers. Fingerprint comparison methods. Face identification. Voice identification. Heart rate authentication.

Identification by DNA. Signature verification as a biometric parameter. Biometric parameter - gait recognition. Wayman's Taxonomy of Applications in Biometrics. Advantages and disadvantages of biometric parameters. Methods for integrating information on biometric parameters. Forms and ways of presenting digital images in biometrics. The main types of biometrics. Attacks on biometric identifiers. Basic biometric identifiers. Types of fingerprint identification scanners. Security architecture in the Internet of Things. Security requirements in the architecture of the Internet of Things. IoT security conceptual model. Threats arising from the maintenance of the Internet of Things.

III. List of references

Main:

1. Кухарев Г.А. Биометрические системы: Методы и средства идентификации личности человека. – СПб: Политехника, 2001. – 240 с.
2. Болл Руд М., Коннел Джонатан Х., Панканти Шарат, Ратха Налини К., Сеньор Эндрю У. Руководство по биометрии. – М.: Техносфера, 2007. – 368 с.
3. Гафаров Ф.М., Галимянов А.Ф. Искусственные нейронные сети и их приложения. Учебное пособие.: Казань – 2018. – 121 с.
4. Смолин Д.В. Введение в искусственный интеллект: конспект лекций. – М.: ФИЗМАТЛИТ, 2004. – 208 с.
5. Габасов Р., Кириллова Ф. Качественная теория оптимальных процессов. – М.: Наука, 1971. – 508 с.
6. Ляшко С.А. Элементы теории динамических систем. – Балашов: Изд-во Николаев, 2005 – 104 с.
7. Парр Э. Программируемые контроллеры: руководство для инженера/ пер. с англ. – М.: БИНОМ. Лаборатория знаний, 2007. -516с.
8. Петин А.А. Проекты с использованием контроллера Arduino. 2 изд.- БХВ-Петербург, 2015.- 464 с.
9. Муромцев Д.И., Шматков В.Н. «Интернет Вещей: Введение в программирование на Arduino» – СПб: Университет ИТМО, 2018. – 36 с.
10. Ситников Д.В., Силков М.В. Теория оптимальных систем автоматического управления: метод. указания к лаб. работам– Омск : Изд-во ОмГТУ, 2018.
11. Чупин Д.Ю., Ступин А.А., Ступина Е.Е., Классов А.Б. Образовательная робототехника: учебное пособие. — Новосибирск: Агентство «Сибпринт», 2019. — 114 с.
12. Зараменских Е. П. Интернет вещей. Исследования и область применения / Е.П. Зараменских И.Е. Артемьев. - М.: ИНФРА-М, 2016. - 188 с.

Additional:

1.Биометрия от «А» до «Я» полное руководство биометрической идентификации и аутентификации https://securityrussia.com/blog/biometriya.html

2.Кудинов Ю.И., Пащенко Ф.Ф. Теория автоматического управления (с использованием MATLAB – SIMULINK): Учебное пособие. – СПб.: Издательство «Лань», 2016. – 256 с.

3.Громов Ю.Ю., Земской Н.А., Лагутин А.В., Иванова О.Г., Тютюнник В.М. Специальные разделы теории управления. Оптимальное управление динамическими системами: учеб. пособие. – Тамбов: Изд-во Тамб. гос. техн. ун-та, 2007. – 108 с

4.Габасов Р., Кириллова Ф. Качественная теория оптимальных процессов. – М.: Наука, 1971. – 508 с.

5.Грингард, Сэмюэл Интернет вещей: Будущее уже здесь / Сэмюэл Грингард. - М.: Альпина Диджитал, 2015. - 261 с Петров И.В. Программируемые контроллеры. Стандартные языки и приемы прикладного проектирования/ Под ред. проф. В.П. Дьяконова. – М.: СОЛОН-Пресс, 2004. – 256 с.