

**APPROVED
at a meeting of the
Scientific Council
NJSC «Al-Farabi KazNU».
Minutes No.10 dated
May 23, 2022.**

**The program of the entrance exam for applicants to the PhD
for the group of educational programs
D100 - Automation and control**

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 separately.

2. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D100- «Automation and control» 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 "**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's 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.

3. 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.
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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.
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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., Пашенко Ф.Ф. Теория автоматического управления (с использованием MATLAB – SIMULINK): Учебное пособие. – СПб.: Издательство «Лань», 2016. – 256 с.
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