

Ministry of Agriculture of the Republic of Kazakhstan  
S.Seifullin Kazakh Agrotechnical University.

Reviewed by  
at the meeting of the scientist  
university council  
Protocol number 15 dated 30  
05 2019

APPROVE  
Chairman of the Board  
JSC "S.Seifullin Kazakh Agrotechnical  
University"



A.K. Kurishbayev  
05 2019

**EDUCATIONAL PROGRAM**  
**"System Engineering"**

(name of the program)

Education Area Code and Classification : 8D061 Information and Communication Technologies

Code and classification areas of training: 8D061 Information and communication technology

Code in the International Standard Classification of Education :

Qualification doktor\_doktor Philosophy PhD/educational program  
**"Systems Engineering"**

Duration: 3 years

Nur-Sultan 2019

Authors:

1. Full name - academic degree, title, position, place of work

Adamova Aigul Dyuenbinovna	PhD, Head of Computer Engineering and Software Department, S.Seifullin KazATU
Gruzin Vladimir Vasilyevich	Doctor of Technical Sciences, Professor, Department of Computer Science and Software, S.Seifullin KazATU
Akanova Akerke Saparovna	Senior Lecturer, Computer Engineering and Software Department, S.Seifullin KazATU

**Educational program "System Engineering"**  
p reviewed at the meeting of the department "Computer Engineering and Software"  
protocol № 7 of "13" on February 9, the 201,

approved by the Faculty Council  
protocol № 11 "14" on February 9 of 201

Dean of the Faculty



Sarbasova K.A.

Head of Department



Adamova A.D.

## Content

No	Component Name	
1	Passport of the educational program	
2	General characteristics of the educational program	
3	Competency model ( portrait) of the graduate	
4	Base professional practice	
5	Structure of the educational program	
6	<b>Application 1.</b> Academic calendar	
7	<b>Application 2.</b> Working curriculum	
8	<b>Application 3.</b> Description of the disciplines of compulsory and university components	
9	<b>Application 4.</b> Description of the disciplines of the component by choice	

## 1. Passport of the educational program

**The purpose of the educational program** Preparation of highly qualified comprehensively developed, intelligent, with analytical skills of scientists in the design, creation and exploitation of structurally complex, large-scale, man-machine and sociotechnical *systems* and knowledge principles, methods and their means development.

**The task of the educational program " Systems Engineering " is**

- develop creative thinking to develop innovative ICT solutions for the agro-industrial sector ;
- form a scientific approach to formulate and solve problems from the standpoint of the system approach methodology of the general theory of complex systems ;
- to improve the educational process of training highly qualified specialists in the field of system engineering.

After the successful completion of the educational program Dr. PhD owns a scientific and theoretical and practical knowledge in the field of ICT, it is able to solve scientific problems in project management skills has the hardware and software implementation of complex systems, clustering and data analysis, can be engaged in research and teaching, production and technology, experimental research, the experience of HO- engineering, design and technological activities that correspond to the 8th level of qualification on the national qualification framework (NQF) and the sectoral qualification framework (QMS). According to the results of the successful implementation of the educational program , a degree is awarded the doctors PhD philosophy " **Systems Engineering** " .

## **2. General characteristics of the educational program**

### **Relevance**

The educational program "Systems Engineering" in the direction of training Information and communication technology is designed to carry out the research and the preparation of I, I advanced the skills and knowledge for those planning an academic, industrial or research careers in ICT.

### **Feature and competitive advantages :**

A distinctive feature of the second yu educational program is to ensure the development of the ability to carry out her doctoral research, and high-performance design of high level that will make a significant contribution to the development and improvement of the field of systems engineering.

As part of the educational program, doctoral students become successful researchers, practitioners and teachers who use a systems approach to navigate and manage complex systems and can solve issues of system integration, life cycle problems and systems thinking.

The educational program is based on research activities, doctoral students work under the guidance of domestic and foreign supervisor. During the doctoral studies, the student is available electronic resources database Scopus, Web of Science. Each doctoral candidate may conduct scientific research in the Laboratory of Information's technology, systems study first, artificial intelligence, it nezrushayusch I control, robotics and mechatronics.

The following stakeholders were interested in the development of the educational program :

- Kazakh Association of IT Companies ;
- Kazakhtelecom JSC ;
- LLP "Kazdream Technologies" ;
- TOO "G1 Software Kazakhstan";
- TOO "OPEN SYSTEMS DEVELOPMENT";
- LLP " QLT " ;
- Kazakhstan GIS Center JSC Ministry of Defense of the Republic of Kazakhstan ;
- LLP " ArtaSoftware " ;
- LLP "Intellectual systems and networks" .

### **3. Competency model (portrait) of the graduate**

**Spheres a professional activity** PhDs who have mastered the program " System Engineering " includes areas and ICT in all spheres of human activity. Doctor PhD Catching th tsya scientific, pedagogical and managerial activities in research organizations, in IT companies and in higher educational institutions.

PhD on the preparation of " System Engineering " has knowledge of the following **professional activities** :

Research: research, analysis, evaluation and comparison of theoretical concepts of information technology in the industrial fields, in the agro-industrial sector, in the economy, in transport .

Pedagogical: preparation of bachelors , masters and doctors ( PhD ) , participation in research activities of the university.

Management: to contribute their own original research to expand the boundaries of the application of information technology .

Constructive: n USAGE, designing, development, implementation and operation of computer systems and software and hardware systems.

#### **General educational competencies**

- possess the methodology of a systematic approach to the organization, modern approaches to management and analytical management methods, methods of diagnostics, analysis and problem solving, as well as methods of decision making and their implementation in practice;

- competently solve practical problems of management and implement these solutions, be prepared for the implementation of management functions and be able to solve professional problems in the interests of the organization as a whole;

- possess the knowledge, skills and abilities necessary for taking up a relevant managerial position and based on a deep understanding of the characteristics of a market economy and its capabilities, functions and economic role of the state, understanding environmental problems, awareness of the social responsibility of business and adherence to the civilized ethical norms of its conduct ;

- be able to assess contemporary problems and prospects of social economic development of Kazakhstan, to understand the current trends in the development of the world economy and globalization, to navigate in matters of international competition.

#### **Core competencies**

- demonstrate a systematic understanding of the field of study, mastering the skills and research methods used in this field;

- demonstrate the ability to think, design, implement and adapt the essential research process with a scientific approach;

- contribute by own original research to expanding the boundaries of the scientific field, which deserves publication at the national or international level;
- critically analyze, evaluate and synthesize new and complex ideas;
- communicate their knowledge and achievements to colleagues, the scientific community and the general public;
- to promote the advancement in the academic and professional context of the technological, social or cultural development of a society based on knowledge.

Doctoral student's completion of the educational program "System Research" must have the following **professional** competencies:

- the ability to apply the general scientific methodology, logic and technology of research to write a doctoral dissertation; correct assessment and application of information for writing a doctoral dissertation and abstract; understanding of the features of building a doctoral dissertation and building a dissertation structure;

- knowledge and ability to apply the axioms and laws of the general theory of complex systems; the formation of systemic thinking; the ability to explore objects representing systems; perform the analysis of the studied system or process; designing complex systems; acquisition of skills to identify and account for the laws of functioning and development of complex systems; use of a systematic approach in solving problems of complex systems ;

- carry out the study of complex systems on their statistical models; obtaining the results of statistical modeling of complex systems using modern computer tools; choose modeling methods, build an adequate system model; interpret and analyzesimulation results;

- analyze promising cyber defense methods; evaluate the security level of Internet of Things; identify cybersecurity sources, determine their characteristics, as well as their classification; monitor and plan measures to protect systems from cyber threats; research of methods of elimination of vulnerabilities of difficult systems the Internet of things .

## 4 Base professional practice

**Pedagogical practice for doctoral students** in the system of postgraduate education is an important and integral component of doctoral educational programs and is a type of practical activity of students in the implementation of the educational and educational process in higher education, including teaching courses, organizing educational activities of students, scientific and methodological work, obtaining skills and practical teaching skills.

The main basis of the teaching practice of doctoral students is the graduating department "Computer Engineering and Software".

**The research practice of doctoral students** is a mandatory component of the doctoral program and is a type of practical activity associated with conducting research in the framework of the chosen topic of the dissertation research, the preparation of scientific publications and the analytical part of the dissertation work .

The research practice of doctoral students is aimed at deepening and systematization of theoretical and methodological training of a doctoral student, as well as at the formation and development of research competencies necessary for the analysis of modern scientific achievements, the use of scientific research methods in solving practical scientific problems.

**The basis for research practice can be \*:**

- Laboratory of Information Technologies;
- Laboratory of system research;
- Laboratory Artificial intelligence;
- Laboratory Non-disruptive control;
- Laboratory of Robotics and Mechatronics;
- Laboratories of the University of Milan (Italy);
- Laboratories / research institutes of BSUIR (Belarus).

\* the list of databases of practices is not limited to this list, in the process of organizing the professional practice of doctoral students , interested domestic and foreign structural divisions are involved .



## 5 The structure of the educational program of doctoral studies in the scientific and pedagogical direction

No. p/p	The name of the cycles of disciplines and activities	Total complexity	
		in academic hours	in academic credits
1	2	3	4
<b>1</b>	<b>Educational component</b>	<b>1590</b>	<b>53</b>
<b>1.1</b>	<b>The cycle of basic disciplines (DB)</b>	<b>600</b>	<b>20</b>
<b>1)</b>	<b>University component</b>		
	Scientific basis for the preparation of a doctoral dissertation	180	6
<b>2)</b>	<b>Component of choice (KV)</b>		
	Theory of Complex Systems	180	6
<b>3)</b>	<b>Teaching practice</b>	<b>240</b>	<b>8</b>
<b>1.2</b>	<b>The cycle of the main disciplines (PD)</b>	<b>990</b>	<b>33</b>
<b>1)</b>	<b>University component</b>		
	Statistical modeling methods	180	6
<b>2)</b>	<b>Component of choice (KV)</b>		
	Analysis and research of methods for detecting vulnerabilities of Internet of Things devices	180	6
	University Component and (or) Optional Component		
<b>3)</b>	<b>Research practice</b>	630	21
<b>2</b>	<b>Research work</b>	<b>3450</b>	<b>115</b>
1)	Doctoral student research work, including internship and doctoral dissertation		
2	Additional types of training		
<b>3</b>	<b>final examination</b>	<b>360</b>	<b>12</b>
1)	Writing and defending a doctoral dissertation	360	12
	<b>Total</b>	<b>5400</b>	<b>180</b>



## **Application 2 Working curriculum**



## Application 3 Discipline description mandatory and university components

<b>1. Basic information about the discipline:</b>	
Name of the discipline	Scientific basis for the preparation of a doctoral dissertation
<b>2. Number of credits</b>	6
<b>3. Prerequisites:</b>	Methods of scientific research , Systemology , Systems analysis , Features of understanding systemicity , Fundamentals of the general theory of complex systems
<b>4. Post requisites:</b>	Research work, internship, doctoral dissertation
<b>5. Competences:</b>	the ability to apply general scientific methodology, logic and technology of research to write a doctoral dissertation; correct assessment and application of information for writing a doctoral dissertation and abstract; understanding of the features of building a doctoral dissertation and building a dissertation structure
<b>6. Course author</b>	Professor, Doctor of Technical Sciences Gruzin V.V.
<b>7. Primary literature</b>	<ol style="list-style-type: none"> <li>1. Abramenzov DE, Abramenzov EA, Gruzin V.V. Methodology of scientific creativity: Textbook. Karaganda: Bolashak-Baspa, 2007. - 342 with.</li> <li>2. Abramenzov DE, Abramenzov E.A., Gruzin V.V. Workshop on the methodology of scientific creativity. Tutorial. Karaganda: Bolashak-Baspa, 2004. - 162 with.</li> <li>3. Abramenzov DE, Abramenzov EA, Gruzin V.V. Methodology of scientific creativity: Textbook. Karaganda: Bolashak-Baspa, 2001. - 328s.</li> <li>4. Gruzin V.V. Technology research Methodical features of the work on the thesis. - Karaganda: Bolashak-Baspa, 2002. - 80s.</li> </ol>

### 8. The content of the discipline

Module 1. Introduction. Basic concepts and definitions:

1. Introduction to the discipline: basic requirements and regulations. Basic terms and concepts
2. Methodology of building a doctoral dissertation. Types of dissertations
3. The structure of theses. Aspects of building a doctoral dissertation. Examples of theses.

Module 2. Scientific dissertation office:

1. Name and relevance of the topic of doctoral dissertation.
2. Purpose, object and subject of research.
3. Tasks and research methods.
4. Scientific novelty of research
5. Practical value, publications and personal contribution of the researcher.

Module 3. Features of scientific research:

1. Methods of research. Classification of research methods.
2. The logic of the process of scientific research.
3. Features of the preparation of scientific publications.

Module 4. The main stages of scientific research:

1. Building a table of contents for a doctoral dissertation. The structure of the abstract and the construction of the doctoral dissertation.
2. Stage 1. Review and analysis of the state of the research problem. Development of the structural scheme of the study.
3. Stage 2. Theoretical and experimental research on the topic of a doctoral dissertation.
4. Stage 3. Practical application of the results of a doctoral dissertation.
5. The formulation of the main conclusions of the chapters and conclusions in a doctoral dissertation.

<b>1. Basic information about the discipline:</b>	
Name of the discipline	Statistical modeling methods
<b>2. Number of credits</b>	6
<b>3. Prerequisites:</b>	Mathematical foundations of information technology, Series Theory and Differential Equations, Big Data Classification, Research Methods, Computer Modeling and Design Systems
<b>4. Post requisites:</b>	Research work, internship, doctoral dissertation
<b>5. Competences:</b>	perform research of complex systems on their statistical models; obtaining the

	results of statistical modeling of complex systems using modern computer tools; choose modeling methods, build an adequate system model; interpret and analyze simulation results
<b>6. Course author</b>	Department Computer Engineering and Software
<b>7. Primary literature</b>	<ol style="list-style-type: none"> <li>1. Afanasyev V.N. Statistics: additional chapters to the section "Development of Methodology forecasting ": a textbook for graduate students / V.N. Afanasyev; Orenburg State. un-t - Orenburg: OSU, 2017. - 111 p. - ISBN 978-5-4417-0679-7.</li> <li>2. Afanasyev VN Statistical methodology in scientific research: studies. allowance for graduate students / V.N. Afanasyev, N.S. Yermeeva, T.V. Lebedeva; Orenburg State. un-t - Orenburg: OSU, 2017. - 245 p. - ISBN 978-5-4417-0680-3.</li> <li>3. Afanasyev, V.N. Time-series analysis and forecasting [Text]: textbook / V. N. Afanasyev, M.M. Yuzbashev. - Moscow: Finance and Statistics, 2012. - 319 p. - 978-5-279-03400-0.</li> <li>4. Theory of Statistics: an educational complex [Electronic resource] / V. G. Minashkin, N. A. Sadovnikova, R. A. Shmoylova, L. G. Moiseikin, E. S. Darda. - Moscow: Eurasian Open Institute, 2011. - 400 p. - 978-5-374-00529-5. Access mode: <a href="http://biblioclub.ru/index.php?page=book&amp;id=90763">http://biblioclub.ru/index.php?page=book&amp;id=90763</a>.</li> </ol>
<b>8. The content of the discipline</b>	Unified statistical methodology for the study of mass phenomena in society and nature. Statistical distributions and statistical patterns. Statistical sampling theory. Statistical hypothesis testing. Experiment planning and analysis of variance. Theory of correlation and regression. Pair Correlation and Regression. Multiple correlation and regression. Time series analysis. Features of correlation and regression of time series. Statistical methods in the prediction of phenomena and processes.

## Application 4 Description disciplines component optionally

<b>1. Basic information about the discipline:</b>	
Name of the discipline	Theory of Complex Systems
<b>2. Number of credits</b>	<b>6</b>
<b>3. Prerequisites:</b>	Research methods . Systemology . System analysis . Features understanding of consistency
<b>4. Post requisites:</b>	Research work, internship, doctoral dissertation
<b>5. Competences:</b>	knowledge and ability to apply the axioms and laws of the general theory of complex systems; the formation of systemic thinking; the ability to explore objects representing systems; analyze the system or process under study; designing complex systems; acquisition of skills to identify and account for the patterns of functioning and development of complex systems; using a systematic approach to solving problems of complex systems
<b>6. Course author</b>	Professor, Doctor of Technical Sciences Gruzin V.V.
<b>7. Primary literature</b>	Volkova V.N. Systems Theory: Study Guide / V.N. Volkova, A.A. Denisov. - M.: Higher., 2006. - 511c. Abramenkov DE, Abramenkov E.A., Gruzin V.V. Methodology of scientific creativity. - 2nd ed., Pererab. and add. - Karaganda: Bolashak-Baspa, 2007. - 337 p. Gruzin V.V. Karaganda: Basics of system analysis. Tutorial. Bolashak-Baspa, 2007. - 160s. Gruzin V.V. Fundamentals of the theory of information systems: Tutorial. - Karaganda: Bolashak-Baspa, 2004. - 115s. Dushin V.K. Theoretical foundations of information processes and systems: Textbook. - Publishing and trading corporation "Dashkov and K °", 2003. - 348c. System analysis and decision making: Vocabulary: A study guide ed. VN Volkova, VN Kozlov. - M.: Higher. shk., 2004 - 616s. System Theory and Systems Analysis in the Management of Organizations: A Handbook: Tutorial / Ed. VN Volkova and A.A. Emelyanov. - M.: Finance and Statistics, 2006. - 848c.
<b>8. The content of the discipline</b>	
<ol style="list-style-type: none"> <li>1. Systems and patterns of their functioning and development.</li> <li>2. Transients. Feedback principle.</li> <li>3. Methods and models of systems theory.</li> <li>4. Manageability, reachability, stability.</li> <li>5. Elements of the theory of adaptive systems.</li> <li>6. Basics of system analysis: the system and its properties; descriptive and constructive definitions in system analysis; principles of consistency and complexity; principle of modeling; types of scales.</li> <li>7. The concept of goals and patterns of goal formation: definition of the goal; patterns of targeting; types and forms of representation of target structures; methods of analyzing the goals and functions of control systems.</li> <li>8. Ratios of categories such as event, phenomenon, behavior.</li> <li>9. The functioning of systems in conditions of uncertainty; risk management.</li> <li>10. Methods of organizing complex examinations.</li> <li>11. Analysis of information resources.</li> </ol>	

<b>1. Basic information about the discipline:</b>	
Name of the discipline	Analysis and research of methods for detecting vulnerabilities of Internet of Things devices
<b>2. Number of credits</b>	<b>6</b>
<b>3. Prerequisites:</b>	IOT technology, Mathematical foundations of information technology, Series Theory and Differential Equations, Big Data Classification, Research Methods, Computer Modeling and Design Systems, Statistical Modeling Methods
<b>4. Post requisites:</b>	Research work, internship, doctoral dissertation
<b>5. Competences:</b>	analyze promising cyber defense methods; evaluate the security level of Internet of Things; identify cybersecurity sources, determine their characteristics, as well as their classification; monitor and plan measures to protect systems from cyber threats; research methods to eliminate the vulnerabilities of complex systems Internet of Things

<b>6. Course author</b>	PhD Adamova AD
<b>7. Primary literature</b>	<p>1. J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A vision, architectural elements, and future directions," <i>Futur. Gener. Comput. Syst.</i>, Vol. 29, no. 7, pp. 1645-1660, 2013.</p> <p>2. <a href="https://diginomica.com/2018/09/24/california-passes-nations-first-iot-security-bill-too-little-too-late/">https://diginomica.com/2018/09/24/california-passes-nations-first-iot-security-bill-too-little-too-late/</a></p> <p>3. <a href="https://www.kaspersky.ru/about/press-releases/2017_international-recommendations-for-the-industrial">https://www.kaspersky.ru/about/press-releases/2017_international-recommendations-for-the-industrial</a></p> <p>4. Ali, Mohammed AlSaudi &amp; Motawa, Dyaa &amp; Al-harby, Fahad. (2018). Internet of Things and Distributed Denial of Service Mitigation. 26-36. 10.1007 / 978-3-319-60585-2 3.</p>
<b>8. The content of the discipline</b>	<p>Securing the Internet of Things . Device certification . sensor networks. security at the level of perception, security at the network level, security at the application level, software vulnerabilities. Network operation and security: the importance of a comprehensive solution. Cyber physical security; Cryptographic engineering; Cryptanalysis; neuromorphic channel side attack engineering and countermeasures .</p>