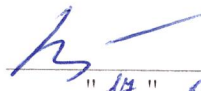


AGREED

Chairman of the Educational and  
Methodological Council JSC «International  
University of Information Technologies»

  
A.K. Mustafina  
"14" 03 2023

APPROVE

Chairman of the Board – Rector  
JSC International University of  
Information Technologies

  
A.K. Khikmetov

## EDUCATIONAL PROGRAM

### 8D06101 "Clever Systems"

(based on the professional standard "Creation and management of IT")

Code and classification of the field of education: 8D06 - Information and communication technologies

Code and classification of areas of study: 8D061 - Information and communication technologies

Group of educational programs: 057 - Information technology

ISCED level: 8

NQF level: 8

ORC level: 8

Duration of study: 3 years

Credits: 180


  
AGREED  
Almaty Technological Institute  
Department "Information Technology"  
Malikova F. U.  
"02" 03 2023

AGREED  
Director J.L.P. "Zerone Technology"  
Rashidinov D.R.  
"02" 03 2023  


The educational program "8D06103 Information Systems" is the main academic document of the university for training personnel in the direction of 8D06 - Information and communication technologies for the 8th level of qualification (PhD degree).

This educational program was discussed and approved at the meeting of the department "\_3\_" dated " 7 " \_02\_ 2023 Protocol № 3

Head of the Department



signature

Kozhamzharova D.Kh.

This educational program was reviewed and approved at a meeting of the University CC dated March 30, 2023 Protocol No. 8

Manager of the Department



signature

Ajibaeva A. Sh.

for Educational and Methodological Affairs

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## List of abbreviations and symbols

|             |   |
|-------------|---|
| BC          | Basic competence  |
| BM          | Basic module  |
| HE          | Higher education  |
| GOSO        | State obligatory standard of education  |
| ECR         | European Qualifications Framework   |
| ETF         | European Training Foundation  |
| ZUN         | Knowledge, skills, skills   |
| NKZ         | National Classifier of Occupations  |
| NQF         | National Qualifications Framework   |
| NQS         | National Qualifications System  |
| OGM         | General humanitarian module   |
| OM          | General module  |
| OP          | Educational program   |
| OPM         | General professional module   |
| OQF         | Sectoral Qualifications Framework   |
| OK          | General educational competence  |
| PS          | Professional Standard   |
| Air Defense | Postgraduate Education  |
| PC          | Professional competence   |
| PM          | Professional module   |
| WG          | Working Group   |
| RK          | Republic of Kazakhstan  |
| RO          | Learning Outcome  |
| CM          | Special module  |
| QMS         | Quality management system   |
| SEM         | Socio-economic module   |
| TVE         | Technical and Vocational Education  |
| TVET        | Technical and Vocational Education and Post-Secondary education   |
| UNESCO      | United Nations Educational, Scientific and Cultural Organization/   |
| UNESCO      | is a specialized agency of the United Nations Educational, Scientific and Cultural Affairs.   |
| Cedefop     | European Center for the Development of Vocational Training  |
| DACUM       | from English Developing Curriculum  |
| ECVET       | European Credit System for vocational education and training  |
| EQAVET      | European Quality Assurance in Vocational Education and Training   |
| ENQA        | European Association for Quality Assurance in Higher Education / European - Russian Association for Quality Assurance in Higher Education |
| ESG         | Standards and Guidelines for Quality Assurance in the European Higher Education Area  |
| FIBAA       | International agency (non-profit foundation) for accreditation and examination of the quality of higher education (Bonn, Germany)         |
| IQM-HE      | Internal Quality Management in Higher Education   |
| TACIS       | Technical Assistance for the Commonwealth of Independent States   |
| WSI         | WorldSkills International   |

## 1. Description of the educational program

This educational program (EP) was developed on the basis of professional standards (PS) of the National Chamber of Entrepreneurs "Atameken", the National Qualifications Framework (NQF), the Sectoral Qualifications Framework (SQF) in the field of information technology and regional standards (RS) of education, based on research and trends indicated in the Atlas of new professions and competencies (ANPiK) of Kazakhstan in the field of information technology.

An intelligent system is an advanced computer system that can collect, analyze and respond to the data it collects from its environment. An intelligent system can work and communicate with other agents such as users or other computer systems, can learn from experience and adapt to current data. The intelligent system can also support remote monitoring and control. Intelligent systems automate work tasks and create intelligent environments; they make machines communicate with each other - for example, in the field of mobile payments, healthcare, traffic, security or surveillance, etc.

In this educational program, doctoral students will develop and implement solutions for consumer technologies such as smart cities, homes, etc. Doctoral students will study data mining, machine learning, deep learning, neural networks, etc. In addition, they will plan, develop and implement projects of intelligent information systems and the Internet of things.

The PhD- level educational program is a co-educational program for all IT programs and provides professional qualifications

- in the field of representation and processing of knowledge in intelligent systems,
- in the field of studying methods for constructing logical models and their use in intelligent systems for various purposes: fuzzy systems, decision support systems, neural network and genetic algorithms.

Theoretical research is aimed at studying intellectual processes and creating appropriate mathematical models. Experimental work is carried out by compiling computer programs and creating machines that solve particular intellectual problems or behave reasonably in a given situation.

The educational program will contribute to the formation of the doctoral student's skills and abilities in the areas of solving design and control problems based on artificial intelligence methods, advanced technologies, software development for modern intelligent systems.

## 2. Purpose and objectives of the educational program

### **The purpose (goals) of mastering the discipline:**

Training of competent research personnel to meet the needs of science, education and production in the field of modern intelligent systems.

### **Tasks:**

- familiarization with the concepts and methods that form the basis for understanding modern achievements of artificial intelligence;
- presentation of the technical statement of the main tasks solved by artificial intelligence systems;
- familiarization with modern areas of research on artificial intelligence;
- familiarization with the main models of knowledge representation and intellectual systems;
- development of intelligent information systems or systems based on knowledge.

The doctoral student must have the skills of data analysis and analytical generalization of the results of scientific research using modern achievements in science and technology, the study, analysis and generalization of scientific and technical information on the subject of dissertation research, the ability to create theoretical models that allow predicting the properties of the objects under study, and develop proposals for the implementation of the results.

### 3. Requirements for evaluating the learning outcomes of an educational program

The following forms of exams are used as an assessment of learning outcomes: computer testing, written exam (answers on sheets), oral exam, project (passing a course project), practical (open questions on a computer, solving problems on a computer, including in the ACM format), complex (test / written / oral + others). In accordance with table 1, the following ratio of exam forms is recommended:

Table 1

| No. | Exam form        | Recommended share, % |
|-----|------------------|----------------------|
| 1   | Computer testing | 5%                   |
| 2   | Writing          | 25 %                 |
| 3   | Oral             | 60%                  |
| 4   | Project          | 5%                   |
| 5   | Practical        | 0%                   |
| 6   | Complex          | 5%                   |

Disciplines submitted for the state exam: "Data Mining in IS", Theoretical Computer Engineering, "Analysis Methods and Big Data Processing".

## 4 Passport of the educational program

### 4.1 General information

| No | Field name  | Note   |
|----|---|--|
| 1  | Code and classification of the field of education   | 8D06 - Information and Communication Technology  |
| 2  | Code and classification of areas of study   | 8D061 – Information and Communication Technology   |
| 3  | Group of educational programs   | 057 - Information technology   |
| 4  | Name of the educational program   | 8D06101 "Clever Systems"   |
| 5  | Brief description of the educational program  | The PhD level educational program is a co-educational program for all IT programs and provides professional qualifications <ul style="list-style-type: none"> <li>• in the field of representation and processing of knowledge in intelligent systems,</li> <li>• in the field of studying methods for constructing logical models and their use in intelligent systems for various purposes: fuzzy systems, decision support systems, neural network and genetic algorithms.</li> </ul> |
| 6  | Purpose of the EP   | Training of competent research and teaching staff to meet the needs of science, education and production in the field of modern intelligent systems.   |
| 7  | ISCED level   | 8  |
| 8  | NQF level   | 8  |
| 9  | ORC level   | 8  |
| 10 | List of competencies<br><b>Basic competence (BC):</b><br>BC1: the ability to know the basic algorithms of intelligent systems, patterns of intellectual |  |

|    |  |
|----|--|
|    | <p>processes, methods of data analysis, data processing and presentation using data science;<br/> BC2: the ability to effectively plan, implement, configure and maintain the organization's computer infrastructure;<br/> BC3: the ability to acquire with the help of advanced modern technologies and put into practice new knowledge and skills, including in new areas of knowledge that are not directly related to the field of activity;<br/> BC4: possession of methods and means of obtaining, storing, processing and broadcasting information through modern computer technologies, in intelligent systems;<br/> BC5: culture of thinking, the ability to build the logic of reasoning and statements based on the interpretation of data, integrated from different areas of science and technology, to make judgments based on incomplete data ;<br/> BC6: the ability to organize interaction between the development team and the customer; making managerial decisions in conditions of different opinions ;<br/> BC7: the ability to analyze and evaluate the levels of their competencies, combined with the ability and readiness for self-regulation of further education and professional mobility;<br/> BC8: the ability to know and apply the basics of neural network design, their basic customizations and settings.</p> <p><b>Professional competencies (PC):</b><br/> PC1: the ability to analyze professional information, highlight the main thing in it, structure, format and present in the form of analytical reviews with reasonable conclusions and recommendations ;<br/> PC2: ability to develop terms of reference for specifications; formulate terms of reference and criteria for the effectiveness of intelligent systems;<br/> PC3: ability to develop new methods for designing and developing intelligent systems;<br/> PC4: the ability to build knowledge representation models, approaches and techniques for solving problems of artificial intelligence, intelligent knowledge models, knowledge representation methods (knowledge engineering methods);<br/> PC5: the ability to develop and program human-computer interaction, solve optimization problems using artificial intelligence algorithms;<br/> PC6: the ability to develop methods for solving non-standard problems and new ways of solving traditional problems;<br/> PC7: ability to develop design strategies, definition of design goals, performance criteria, applicability limitations;<br/> PC8: the ability to predict the development of intelligent systems and advanced information technologies;<br/> PC9: ability to develop competitive ideas in the theory and practice of advanced technologies and intelligent systems;<br/> PC10: ability to professionally operate modern equipment and instruments (in accordance with the goals of the doctoral program) ;<br/> PC11: ability to design and develop a universal self-learning AI;<br/> PC12: ability to conduct staff training.</p> |
| 11 | <p><b>Learning Outcomes</b></p> <p>LO1 Formulate research problems and find ways to solve them based on models and methods of data mining, machine learning, neural networks, theories of computational complexity and optimization;<br/> LO2 Demonstrate the patterns of cognition of intellectual processes, methods of searching, processing and presenting professionally significant data;<br/> LO3 Apply big data processing and data mining methods to solve resource-intensive tasks;<br/> LO4 Apply machine learning algorithms and implement them in intelligent systems;<br/> LO5 Develop intelligent information systems and their components based on modern methods of data science;<br/> LO6 Generate own new scientific ideas in a specific subject area and communicate</p>   |

|    |   |  |
|----|---|--|
|    | <p>them to the scientific community;</p> <p>LO7 Propose substantiated applications or explanatory notes for research projects in the field of intelligent systems;</p> <p>LO8 Design models and develop the architecture of artificial neural networks for specific subject areas;</p> <p>LO9 Develop algorithms and rules for analysis, decision-making, work, learning and self-learning, communication, interaction and development of universal AI;</p> <p>LO10 Evaluate own and known scientific research and prepare analytical materials for the development of strategic decisions in the field of intelligent systems.</p> |  |
| 12 | Form of study   | full-time  |
| 13 | Language of instruction   | English  |
| 14 | Volume of loans   | 180  |
| 15 | Professional Standards  | Development of artificial intelligence applications, Development of systems for processing and storing big data, Development of IoT systems, Creation and management of information technologies, System analysis in information and communication technologies, Business analysis in information and communication technologies, Business intelligence and IT project management  |
| 16 | Awarded Academic Degree   | Doctor in information and communication technologies in the educational program 8D06101 "Clever Systems" (Intelligent systems)   |
| 17 | Developer(s) and authors:   | <p>JSC "International University of Information Technologies", Department of Information Systems:</p> <p>Head of the PhD section of the Department of Information Systems, Professor, Doctor of Technical Sciences Naizabayeva L.K.</p> <p>Professor of the Department of Information Systems, Doctor of Technical Sciences Sinchev B.K.</p> <p>Senior-lecturer of the Department of Information Systems, Myrzakerimova A.</p> <p>Senior-lecturer of the Department of Information Systems, Auezova A.</p> <p>Lecturer of the Department of Information Systems, Elle V.</p> |

4.2 Matrix of correlating the learning outcomes of the educational program as a whole with the competencies being formed

|     | LO1 | LO2 | LO3 | LO4 | LO5 | LO6 | LO7 | LO8 | LO9 | LO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| BC1 | √   | √   |     |     |     |     |     |     |     |      |
| BC2 | √   | √   |     |     |     |     |     |     |     |      |
| BC3 |     |     | √   | √   |     |     |     |     |     |      |



|      |   |   |   |   |   |   |   |   |   |   |
|------|---|---|---|---|---|---|---|---|---|---|
| BC4  |   |   | √ | √ |   |   |   |   |   |   |
| BC5  |   |   |   |   | √ |   |   |   |   |   |
| BC6  |   |   |   |   |   | √ |   |   |   |   |
| BC7  |   |   |   |   |   |   | √ | √ |   |   |
| BC8  |   |   |   |   |   |   |   |   | √ | √ |
| PC1  | √ |   |   |   |   |   |   |   |   |   |
| PC2  |   | √ | √ | √ |   |   |   |   |   |   |
| PC3  |   | √ | √ | √ |   |   |   |   |   |   |
| PC4  |   | √ | √ | √ |   |   |   |   |   |   |
| PC5  |   | √ | √ | √ |   |   |   |   |   |   |
| PC6  |   |   |   |   | √ |   |   |   |   |   |
| PC7  |   |   |   |   | √ |   |   |   |   |   |
| PC8  |   |   |   |   | √ |   |   |   |   |   |
| PC9  |   |   |   |   |   | √ |   |   |   |   |
| PC10 |   |   |   |   |   |   | √ | √ | √ | √ |
| PC11 |   |   |   |   |   |   | √ | √ | √ | √ |
| PC12 |   |   |   |   |   |   |   |   | √ | √ |

4.3 Information about modules / disciplines (if there are modules, it is necessary to highlight)

| No.  | Name of the discipline      | Brief description of the discipline (30-50 words)   | Number of credits | Formed competencies (codes)        | Prerequisites                          |
|--|-----------------------------|---|-------------------|------------------------------------|--|
| <b>Module 1. The cycle of basic disciplines</b><br><b>University component</b> |                             |   |                   |                                    |  |
| 1  | "Academic Writing"          | Studying the course will allow doctoral students to carry out professional activities related to searching for information in scientific databases, analyzing and summarizing texts, and working with various genres of academic writing.   | 5                 | BC-3, BC-5, BC-7, PC-1             | No                                     |
| 2  | Scientific research methods | The course presents for doctoral students the methodology of research in the field of intelligent systems. Course topics: the importance of research and some information technology research methodologies, ie formal method, prototyping, experiment and evaluation; methods for writing results, such as writing reports, writing articles, and writing abstracts; registration of research results; writing research proposals. | 4                 | BC-1, BC-3, BC-5, BC-7, PC-1, PC-3 | "Fundamentals of research activities"  |
| 3  | Intelligent systems         | The course studies the representation of knowledge in information systems as an element of artificial intelligence  | 4                 | BC-7, PC-4, PC-5, PC-8             | "Programming technologies", "Theory of |

|  |  |   |   |                                    |  |
|--|--|---|---|------------------------------------|--|
|  |  | and new information technologies, the classification of intelligent systems. Technology for the design and operation of intelligent systems. The course studies classes of intelligent systems: expert systems, artificial neural networks, calculation and logic systems, systems with genetic algorithms, natural language systems. Intelligent information systems are characterized by the following features: developed communication skills; the ability to solve complex poorly formalized problems; ability to self-learning; adaptability. |   |                                    | information processes and systems", "Mathematical foundations of systems theory", "Mathematical logic and theory of algorithms". |
| <b>Cycle of basic disciplines<br/>Selectable Component</b> |  |   |   |                                    |  |
|  | <b>Elective discipline - 1</b>                 |   |   |                                    |  |
| 4  | Methods of analysis and processing of big data | The course introduces methods of data storage, effective analysis and extraction of business and socially significant information. The course introduces doctoral students to several key IT technologies for manipulating, storing and analyzing big data. The course covers MapReduce methods for parallel processing and Hadoop, an open source framework. Doctoral students will develop highly scalable systems to accept the storage and analysis of large volumes of unstructured data in batch and/or real-time.                            | 4 | BC-1, PC-4, PC-8, PC-9, PC-10      | "Database management systems", "Object-oriented programming".  |
| 5  | Data mining                                    | The course studies classification, modeling and forecasting methods based on the use of decision trees, artificial neural networks, genetic algorithms, evolutionary programming, associative memory, fuzzy logic. Doctoral students will study methods of data analysis, including statistical methods: descriptive analysis, correlation and regression analysis, factor analysis, analysis of variance, component analysis, discriminant analysis, time series analysis, survival analysis, relationship analysis.                               | 4 | BC-1, BC-4, PC-1, PC-4, PC-8, PC-9 | Statistical data analysis  |
|  | <b>Elective discipline - 2</b>                 |   |   |                                    |  |
| 6  | Modern management theory                       | Management theory is an applied scientific discipline that uses the results of research and development in other branches of science. The management theory course is   | 4 | BC-6, PC-1, PC-3, PC-6, PC-11      | "Project management"   |

|   |                                  |  |   |                         |  |
|---|----------------------------------|--|---|-------------------------|--|
|   |                                  | connected with a number of humanitarian, general professional and special disciplines. The development of management theory takes place in close interaction with such scientific disciplines as: philosophy, sociology, organization theory, psychology, management, personnel management and many others. At the same time, the results of scientific research in the field of management theory are used in such disciplines as the public administration system, municipal management, personnel management, etc.  |   |                         |  |
| <b>Module 2. The cycle of major disciplines<br/>University Component/Elective Component</b> |                                  |  |   |                         |  |
| 7   | Actual problems in forecasting   | In this discipline, doctoral students study the basic principles, construction features and scope of predictive models. The course provides a detailed overview and description of the classification and clustering of forecasting, and focuses on the practical problems involved in forecasting. Doctoral students will implement predictive models using Python and machine learning, as well as implement innovative engineering projects to develop predictive models for various purposes using modern design methods. In the process of learning activities, software implementation of predictive models is carried out to solve practical problems from various fields of application. | 4 | PC-1, PC-5, PC-8, PC-9  | Data mining in IS  |
| 8   | Theoretical computer engineering | The course is a challenging introduction to the basic ideas of theoretical computer engineering. In the course, doctoral students will become familiar with the most important areas and tools of modern computer engineering, along with the theory of algorithms, which includes the development and analysis of computational procedures; and complexity theory, which includes attempts to prove that there are no efficient algorithms in certain cases, and which investigates a classification system for computational problems. Time, memory, randomness, and concurrency are typical measures of computational cost. The course  | 4 | BC-2, PC-2, PC-7, PC-10 | "Database Management Systems", "Programming Technology", "Decision Theory", "Software Engineering" |

|   |                       |   |   |                         |   |
|---|-----------------------|---|---|-------------------------|---|
|   |                       | covers propositional logic, Turing machines and computability, finite automata, Gödel's theorems, efficient algorithms and reducibility, NP-completeness, P versus NP problems, decision trees and other specific computational models, power of randomness, cryptography and one-way functions, computational learning theories, interactive evidence and quantum computing and the physical limits of computing.  |   |                         |   |
| 9 | Deep learning methods | The course covers deep learning methods, training and deployment of neural networks. During the training, doctoral students will experiment with data, training parameters, neural network structure and other parameters to improve the performance and capabilities of neural networks, and deploy neural networks to solve real-world problems. Upon completion of the course, students will be able to solve their own problems using deep learning algorithms. | 4 | PC-4, PC-6, PC-9, PC-11 | "Machine learning", "Methods of automatic text processing", "Analysis and processing of unstructured data", "Neural networks" |



|          |  |           |          |            |           |           |           |  |  |            |           |            |          |           |  |
|----------|--|-----------|----------|------------|-----------|-----------|-----------|--|--|------------|-----------|------------|----------|-----------|--|
| I PP8101 | Research practice  | 10        | 2        | 300        |           |           |           |  |  | 300        | 15        | 285        | 10       |           |  |
|          | <b>Total database for VK</b>   | 14        |          | 420        | 30        | 15        | 15        |  |  | 390        | 30        | 360        | 4        | 10        |  |
| 2)       | <b>2) Component of choice (CV)</b>   | 4         | 1        | 120        | 30        | 15        | 15        |  |  | 90         | 15        | 75         | 4        |           |  |
| SFT8102  | Deep learning methods  |           |          |            |           |           |           |  |  |            |           |            |          |           |  |
| SFT8103  | Modern management theory   |           |          |            |           |           |           |  |  |            |           |            |          |           |  |
| SFT8100  | Actual problems in forecasting   |           |          |            |           |           |           |  |  |            |           |            |          |           |  |
| 2.2      | <b>Total DB KV</b>   | 14        |          | 420        | 30        | 15        | 15        |  |  | 390        | 30        | 360        | 4        | 10        |  |
| 2        | <b>Total DB VK, KV</b>   | <b>18</b> | <b>1</b> | <b>540</b> | <b>30</b> | <b>15</b> | <b>15</b> |  |  | <b>480</b> | <b>45</b> | <b>435</b> | <b>8</b> | <b>10</b> |  |
| II       | <b>II. Research work (PD)</b>  | 115       |          |            |           |           |           |  |  |            |           |            |          |           |  |
| I        | <b>NIRM</b>  | 123       |          |            |           |           |           |  |  |            |           |            |          |           |  |
| NIRD     | Research work of a doctoral student, including an internship and a doctoral dissertation | 5         | 1        | 150        |           |           |           |  |  | 150        | 15        | 135        | 5        |           |  |
| NIRD     | Research work of a doctoral student, including an internship and a doctoral dissertation | 10        | 2        | 360        |           |           |           |  |  | 360        | 90        | 270        | 10       |           |  |
| NIRD     | Research work of a doctoral student, including an internship and a doctoral dissertation | thirty    | 3        | 540        |           |           |           |  |  | 540        | 90        | 450        | thirty   |           |  |






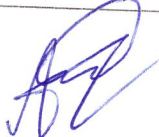

**6. Additional educational programs (Minor)**

| Name of additional educational programs (Minor) with disciplines | Total number of credits | Recommended semesters of study | Documents on the results of the development of additional educational programs (Minor) |
|--|-------------------------|--------------------------------|--|
| Advanced programming in .NET                                     | 4                       | 1                              |  |
| Advanced programming in Java EE                                  | 4                       | 1                              |  |
| Machine learning   | 4                       | 1                              |  |
| Applied robotics   | 4                       | 1                              |  |
| Probability forecasting  | 4                       | 1                              |  |
| Data visualization   | 4                       | 1                              |  |



**6. Developer approval sheet**

Name of the educational program: 8D06101 "Clever Systems"

| No. p / p | Position, scientific or academic degree and Surname Name, educational program developer                                 | Date       | Signature   | Note |
|-----------|---|------------|---|------|
| 1         | Head of the PhD Section of the Information Systems Department, Professor, Doctor of Technical Sciences Naizabayeva L.K. | 11.03.2023 |    |      |
| 2         | Professor of the Department of Information Systems, Doctor of Technical Sciences Sinchev B.K.                           | 11.03.2023 |    |      |
| 3         | Senior lecturer of the Department of Information Systems, Myrzakerimova A.  | 11.03.2023 |    |      |
| 4         | Senior lecturer of the Department of Information Systems, Auezova A.  | 11.03.2023 |   |      |
| 5         | Lecturer of the Department of Information Systems, Elle V.  | 11.03.2023 |  |      |