

AGREED

by the Director of REDPRINT LLP
(Digital Agency NIDGE)M. Ryskeldi
2023

APPROVED

by the Chairman of the Board, Rector of the
JSC «International Information Technology
University»A.K. Khikmetov
2023**EDUCATIONAL PROGRAM****8D06105 «Data Science»**

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

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

Group of educational programs: 057 – Information technologies

Level according to ISCE: 8

Level according to NQF: 8

Level according to SQF: 8

Duration of study: 3 years

Credits: 180

Almaty, 2023

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List of designations and abbreviations

CD	Cycle of core disciplines
CC	Core competency
BM	Basic module
UC	University component
HE	Higher education
NMS	National Mandatory Standards of Higher and Post-Graduate Education
ATT	Additional types of training
EQF	European qualifications framework
EFE	European foundation for education
KSA	Knowledge, Skills and Abilities
FA	Final attestation
OC	Optional component
ISCED	International Standard Classification of Education
NQF	National qualifications framework
NQS	National qualifications system
GHM	General humanitarian module
RC	Required component
GEM	General education module
GED	Cycle of general education disciplines
AP	Academic program
GPM	General professional module
SQF	Sectoral qualifications framework
GEC	General education competence
M	Cycle of majors
PI	Professional internship
PS	Professional standard
PE	Postgraduate education
PC	Professional competence
PM	Professional module
LO	Learning outcome
QMS	Quality Management System

1. Description of the educational program

Data Science — is the science of methods for analyzing data and extracting valuable information and knowledge from it. It intersects closely with such areas as machine learning (Machine Learning) and the science of thinking (Cognitive Science) and, of course, technologies for working with big data (Big Data Analysis).

Currently, the main players in the economic world are becoming increasingly aware of the potential of operational data. They are constantly looking for ways to use their data and extract from them as much useful information as possible. The role of data researchers is to help companies solve this problem by acquiring, storing, organizing and processing this scope of information in order to benefit. A specialist in the field of data science and artificial intelligence should have multidisciplinary skills, starting from a thorough knowledge of mathematics and statistics up to the development of IT tools and infrastructure that is necessary for data management and processing. In addition, research scientists must be curious and thirsty to understand the area of application in which they are working.

PhD in Data Science should:

- take and pass 1 course of theoretical training;
- pass all the necessary exams to prove the acquainting of theoretical knowledge;
- conduct research work within 3 years.

In the process of training in doctoral studies, PhD students can get all of the opportunities that are necessary for engaging in scientific activities, in particular they have:

- access to library resources and electronic catalogs;
- opportunity to consult with their research supervisors and other professors;
- opportunity to communicate and consult with leading scientists from various foreign universities;
- possibility of undergoing foreign internships.

2. Objectives and tasks of the educational program

Objectives and tasks of the educational program

The goal of educational program – is to prepare PhD who are able to become leaders in the field of data research and help them to develop the research skills necessary for career growth in the academic community or in industry.

Tasks of the educational program:

- Develop a deep understanding of key technologies in data science and business analytics: data mining, machine learning, visualization methods, predictive modeling and statistics.
- Practice problem analysis and decision making.
- Get hands-on experience with statistical programming languages and big data tools through research.
- Getting skills to work with neural networks.

3. Requirements for assessment of learning outcomes of educational program

By the end of the educational program, doctoral students will be able to:

- know: the basic methods of spectral problems with symmetric matrices and the solutions of arbitrary systems of equations used in production, technology and science;
- be able to: interpret the results of computational experiments, identify trends, make forecasts;
- have skills: implementing methods of spectral problems with symmetric matrices and solving arbitrary systems of equations using modern software and programming languages.

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

Table 1

№	Examination format	Recommended part, %
1	Computer testing	20%
2	Writing	10%
3	Verbal	5%
4	Project	30%
5	Practical	30%
6	Complex	5%

Final attestation ends with the defense procedure of a doctoral thesis.

4. Passport of the educational program

4.1. General information of the educational program

№	Field name	Note
1	Code and classification of the field of education	8D06 – Information and communication technology
2	Code and classification of training areas	8D061 - Information and communication technology
3	Group of educational programs	057 – Information Technology
4	Name of educational program	8D06105 «Data Science»
5	Brief description of the educational program	The data science education program aims to train doctoral students of data researchers. Data researchers should possess skills and knowledge from several diverse areas: computer science and programming, mathematical methods, and also conduct statistical analysis. Data Science Specialists are highly in demand. The key methods of data analysis today are machine learning, data mining, process mining, visual analytics, time series analysis and others. By analyzing big data, you can create new services and products, optimize your business, and therefore, conduct research in the field of big data. The structure of the educational doctoral program includes two components: educational and scientific, which determine the content of education.
6	Objectives of EP	Teach doctoral students: extract useful information from a large array of information; identification of patterns from large amounts of information; test hypotheses by modeling and developing new software.
7	Level according to ISCE	8
8	Level according to NQF	8
9	Level according to SQF	8
10	GC1: Knowledge of the basic methods of spectral problems with symmetric matrices and the solution of arbitrary systems of equations used in production, technology and science; GC2: The ability to interpret the results of computational experiments, identify trends, make forecasts; GC3: Ability to implement methods of spectral problems with symmetric matrices and solve arbitrary systems of equations using modern software and programming languages. GC4: The ability to correctly use the grammatical constructions of the scientific style of speech. GC5: Ability to write annotations, abstracts, research papers. GC6: Knowledge of the methodological foundations of research conduction and creativity. GC7: Knowledge in the field of similarity and modeling, computational experiment. GC8: Possession of the technique of an optimal experiment design and processing measurement results. GC9: Readiness for teaching activities in the main educational programs of higher education.	

	GC10: Ability to prepare and conduct research in accordance with the focus of the doctoral program, using knowledge of basic and core disciplines of EP. PC1: Know the main optimization methods of the inverse and ill-posed problems used in industry, engineering and science. PC2: To be able to interpret the results of computational experiments, identify trends, make forecasts. PC3: Have the skills to implement optimization methods of the inverse and ill-posed problems using modern software and programming languages. PC4: The ability to use the deep neural network algorithm to solve problems with partial derivatives. PC5: The ability to illustrate ideas with the short MATLAB scripts, which installs and trains the network. PC6: The ability to demonstrate the use of modern software for the large-scale image classification task. PC7: Ability to build decision-making models in situations of conflict and cooperation. PC8: The introduction of the principles of optimality in specified situations, the axiomatic approach to the mathematical formalization of the concepts of justice and rationality. PC9: The ability to conduct statistical research and to study modern statistical methods.	
11	LO1: Apply research methodology in data science. LO2: Solve applied data processing and analysis problems in order to identify implicit dependencies. LO3: Conduct a comprehensive analysis and analytically summarize the results of research using modern scientific and technological tools, obtain the skills of independent data collection, study, analysis and generalization. LO4: Conduct a statistical analysis: build a confidence interval, hypothesis testing, regression and analysis of variance. LO5: Able to analyze data using the Python programming language. LO6: Substantiate the results obtained during the study. LO7: Able to construct a mathematical model of a practical problem and to develop a computer model (software product)	
12	Form of education	Full-time
13	Learning languages	Russian, English
14	Credits	180
15	Awarded academic degree	Doctor of Philosophy PhD according to the educational program "8D06105 - Data Science"
16	Developer (s) and authors:	JSC «International Information Technology University», MCM Department: - Rysbaiuly B. - Ydyrys A.Zh. - Nurtas M.

4.2 Matrix of correlation of learning outcomes of an educational program with formed competencies

	LO1	LO2	LO3	LO4	LO5	LO6	LO7
GC1		V					
GC2		V					
GC3		V					
GC4	V						
GC5	V					V	

GC6	V						
GC7	V						
GC8	V						
GC9	V						
GC10	V					V	
PC1		V					
PC2		V				V	
PC3			V		V		V
PC4					V		
PC5					V		V
PC6			V				V
PC7			V				
PC8			V				
PC9				V		V	

4.3. Information about disciplines

№	Name of module\discipline	Brief description of discipline (30-50 words)	Credits	Competences (codes)	Prerequisites	Postrequisites
General disciplines						
University component						
1.	Academic writing	“Academic Writing” is a compulsory component of the Ph.D. program offered to the IITU Ph.D. It is one-semester five-credit practical course that tailors the students’ research skills and English language competence to their professional/research needs in academic writing. Students in this course will do a lot of reading activities, explore academic writing strategies and formats required at the graduate level, and get ready for independent academic writing for the Ph.D. program. By the end of the course, students will organize and present research portfolio, and write a research article outline.	5	GC4, GC5	-	-
2.	Teaching practice	Practical skills and competencies in teaching at the university; responsibility and creative attitude to scientific and scientific-pedagogical activity.	10	GC9	-	-
3.	Research methods	This course is to introduce research methodology in information technology for postgraduate candidate. The topics of this course are: the importance of Information Technology research, literature review methodology, some research methodology of Information Technology i.e. formal method, literature review, prototype development, experimental and evaluation. The students will be introduced to the differences between quantitative and qualitative studies. Then, the course will discuss the	4	GC6, GC7, GC8	-	-

		technique of result writing, such as report writing, paper writing, and thesis writing. The end of the course will discuss management of research, discussion in this topic will focus on research proposal writing, supervising research activities, and management of research results.				
General disciplines						
Elective component						
4.	Elective 1		4	PC1, PC2, PC3, PC4, PC5, PC6	-	-
	Nonlinear optimization problems of machine learning	The purpose of teaching the discipline "Nonlinear optimization problems" is to teach PhD students methods for solving inverse and ill-posed problems used in data science. Tasks of studying the academic discipline: - mastering optimization methods for solving inverse and ill-posed problems used in practice and in science; - mastering the skills of programming and using commercial programs to solve inverse and incorrect problems and interpret the results of numerical calculations.				
	Deep learning in applied mathematics	The purpose of the course is the application and training of deep neural network methods in problems with partial differential equations, as well as the use of stochastic gradient methods to solve applied problems using MATLAB, which configures and trains coursework networks, the use of modern software to solve large-scale image classification problems.				
5.	Elective 2		4	PC4, PC6, PC7, PC8	-	-
	Advanced deep learning problems	The purpose of the course is to study and apply neural network methods in various tasks, the use of deep learning methods in practical tasks, effective management of neural networks, the use of regularization methods for deep learning and gradient descent algorithm for various types of inverse problems and their application in industry and economics.				
	Game simulation and applications	The objectives of the discipline "Game simulation and applications" are the development of professional knowledge in the field of mathematical theory of decision-making, the formation of skills in the field of mathematical modeling of conflict situations and cooperation. Tasks of the discipline: building models of decision-making in situations of conflict and cooperation, mastering the principles of optimality in these situations, the axiomatic approach to the mathematical formalization of the concepts of justice				

		and rationality.				
Profiling University components						
6.	Research practice	The practice is supervised by the supervisor of the undergraduate and the head of the research unit. The purpose of research practice: systematization, expansion and consolidation of professional knowledge, the formation of graduate skills in independent research work and experiments conduction.	10	GC10	-	-
Profiling Electives						
7.	Elective 3		4	PC9	-	-
	Applied statistical analysis	To provide doctoral students with knowledge of the variety of modern approaches to statistical research, to explore modern statistical methods, to instill a critical approach in the selection of analysis tools and an awareness of the need for careful testing of the statistical adequacy of the resulting models, as well as to develop skills in meaningful interpretation of the results.				
	Enumerative combinatorics	The aim of the course is to acquire skills in applying the methods of enumerative combinatorics to scientific research in various fields. The course covers topics such as binomial coefficients, the inclusion and exclusion formula, nonlinear repetition: the versatility of Catalan numbers, generating functions, generating functions, the Euler generating function for partitions and the pentagonal formula.				
8.	Elective 4		4	GC1, GC2, GC3	Numerical methods	-
	Conditionality of systems of linear equations	The purpose of teaching the discipline "Conditionality of systems of linear equations" intended for PhD students is to study on computers spectral problems with symmetric matrices and solutions of arbitrary systems of equations. Tasks of studying the academic discipline: - mastering spectral problems with symmetric matrices and solving arbitrary systems of equations used in practice and in science; - mastering the skills of programming and using commercial programs for solving spectral problems with symmetric matrices and solving arbitrary systems of equations and interpreting the results of numerical calculations.				
	Machine learning methods and algorithms	"To build a machine learning method, mathematical statistics, numerical methods, mathematical analysis, optimization methods and various techniques for working with data in digital form are used. Therefore, machine learning belongs to the class of artificial intelligence methods. In the proposed				

		course, machine learning methods are implemented on a specific example of the process of heat transfer and in a homogeneous and heterogeneous environment. First, various classes of problems for the equations of moisture and heat transfer are considered. Then mathematical models of the problems under consideration will be constructed. Methods for solving inverse and incorrect problems for each class of problems are being developed. Algorithms for solving the studied problems are being developed. Codes are compiled and computational experiments are carried out based on known experimental data."				
9.	Doctoral research work	Doctoral student research, including internships and doctoral thesis conduction	123	GC10	-	-

4.4. List of modules and learning outcomes

Name of educational program: «Data Science»

Qualification: PhD in sphere of information and communication technology in educational program «8D06105 – Data Science»

Module code / Module Name	Complexity of module in credits	Learning outcomes	Criteria for assessing learning outcomes	Module-forming disciplines Code / Name
BASIC MODULES				
BM01 Pedagogical and research module	4	Knowledge of the methodological foundations of scientific knowledge and creativity. Knowledge in the field of similarity and modeling, computational experiment. Competitiveness in optimal experiment design and processing measurement results.	Verbal survey, testing, report, midterm control, computational and graphic works, Presentation, Report	Research methods
	5	To form skills for the correct use of grammatical constructions of the scientific style of speech.		Academic writing
	10	Competitiveness in writing abstracts and research papers. Possession of the pedagogical technique of the teacher.		Teaching practice
	10	Ability to identify the main tasks solved by the IAC.		Research practice
	123	Knowledge of the mathematical support of the specified problems (complex of procedures or subsystem) and the software of the specified problems (complex of procedures or subsystem), the organizational and legal support of the selected task (complex of procedures or subsystem). Systematization and analysis of the actual materials necessary for writing a term paper, a scientific report and a practice report.		Doctoral research work
PROFILLING MODULES				
PM01 Module of electives	4	Possession of professional skills	Verbal survey, testing, report,	Elective №1
	4			Elective №2

№	Module code	Module name in three languages (kaz / rus / eng)	Discipline Code	Discipline name in three languages (kaz / rus / eng)	Cycles (GED, CD, M)	Components (RC, OC, UC)	Total number of credits (ECTS)	Total number of academic hours	Number of classroom hours				Number of SIS hours		midterm control, computational and graphic works, Presentation, Report	Elective №3
									Total number of classroom hours	lectures	practical classes (sem.)	laboratory classes	Total number of SIS hours	Including TSIS		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

5. Curriculum of the educational program

№	Module code	Module name in three languages (kaz / rus / eng)	Discipline Code	Discipline name in three languages (kaz / rus / eng)	Cycles (GED, CD, M)	Components (RC, OC, UC)	Total number of credits (ECTS)	Total number of academic hours	Number of classroom hours						Number of SIS hours		Form of control (Midterm, End-of-term, examination, CP defense, differential test, DP defense)	Prerequisites (Discipline Code)
									Total number of classroom hours	Including			Total number of SIS hours	Including TSIS				
										lectures	practical classes (sem.)	laboratory classes						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
1 year																		
1 semester																		
1	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	RW8001	Докторанттың ғылыми-зерттеу жұмысы, оның ішінде тағылымдама және докторлық диссертациясының орындалуы / Научно-исследовательская работа докторанта, включая прохождение стажировки и выполнение докторской диссертации / The research work of a PhD student, including an internship and implementation of doctoral thesis		RC	5	150	0	0	0	0	150	15	Report Dif.test	-		

2	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	LAN800 1A	Академиялық жазылым / Академическое письмо / Academic writing	CD	UC	5	150	45	15	30	0	105	15	M, E, Exam
3	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	RM8001	Зерттеу әдістері / Методы научных исследований / Research methods	CD	UC	4	120	45	15	30	0	75	15	M, E, Exam
4	PM01	Таңдау модулі / Модуль элективных дисциплин / Module of electives	MAT851 1	Коданбалы математикаға терең оқыту / Глубокое обучение в прикладной математике / Deep learning in applied mathematics	CD	OC	4	120	45	15	30	0	75	15	M, E, Exam
			MAT850 1	Машиналық оқытудың сызықтық емес онлайндыру мәселелері / Нелинейные оптимизационные проблемы машинного обучения / Nonlinear optimization problems of machine learning											
5	PM01	Таңдау модулі / Модуль элективных дисциплин / Module of electives	MAT851 2	Ойын үтілеу және қосымшалар / Игровое моделирование и приложения / Game simulation and applications	CD	OC	4	120	45	15	30	0	75	15	M, E, Exam
			MAT850 2	Терең оқытудың озық мәселелері / Продвинутые проблемы глубокого обучения / Advanced deep learning problems											
6	PM01	Таңдау модулі / Модуль элективных дисциплин / Module of electives	MAT851 3	Тізімдік комбинаторика / Перечислительная комбинаторика / Enumerative combinatorics	M	OC	4	120	45	15	30	0	75	15	M, E, Exam
			MAT850 3	Коданбалы статистикалық талдау / Прикладной статистический анализ / Applied statistical analysis											
7	PM01	Таңдау модулі / Модуль элективных дисциплин / Module of electives	MAT852 1	Машиналық оқыту әдістері мен алгоритмдері / Методы и алгоритмы машинного обучения / Machine learning methods and algorithms	M	OC	4	120	45	15	30	0	75	15	M, E, Exam
			MAT852 0	Сызықтық теңдеулер жүйесінің шартталығы / Обусловленность систем линейных уравнений / Conditionality of systems of linear equations											
				Total number for a 1 semester:			30	900	270	90	18	0	630	105	
2 semester															
8	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	RW8002	Докторанттың ғылыми-зерттеу жұмысы, оның ішінде тағылымдама және магистрлік диссертациясының орындауы (NIRD) / Научно-исследовательская работа докторанта, включая прохождение		RC	15	450	0	0	0	0	450	15	Report Dif.test

3 year													
5 semester													
14	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	RW8005	Докторанттың ғылыми-зерттеу жұмысы, оның ішінде тағылымдама және докторлық диссертациясының орындауы / Научно-исследовательская работа докторанта, включая прохождение стажировки и выполнение докторской диссертации / The research work of a PhD student, including an internship and implementation of doctoral thesis	RC	30	900	0	0	0	0	15	Report Dif.test
Total number for a 5 semester:						30	900	0	0	0	0	15	
6 semester													
15	BM01	Педагогикалық және зерттеу модулі / Педагогическо-исследовательский модуль / Pedagogical and research module	RW8006	Докторанттың ғылыми-зерттеу жұмысы, оның ішінде тағылымдама және докторлық диссертациясының орындауы / Научно-исследовательская работа докторанта, включая прохождение стажировки и выполнение докторской диссертации / The research work of a PhD student, including an internship and implementation of doctoral thesis	RC	18	540	0	0	0	0	15	Report Dif.test
16				Докторлық диссертацияны жазу және қорғау / Написание и защита докторской диссертации / Writing and defending a doctoral dissertation		12	360	0	0	0	0	15	Defence PhD thesis
				Total number for a 6 semester:		30	900	0	0	0	0	30	
				TOTAL NUMBER FOR THE 3 YEAR:		60	1800	0	0	0	0	45	
				TOTAL:		180	5400	0	0	0	0	240	

6. Developer (s) Approval Sheet

Name of educational program: 8D06105 «Data Science»

№	Position, scientific or academic degree and full name of developer of educational program	Data	Signature	Note
1	Professor, Doctor of Ph.-M. Sc-s Rysbaiuly B.			
2	Assistant professor, PhD Ydyrys A.Zh.			
3	Assistant professor, PhD Nurtas M.			