Institute of Automation and Information Technology
Department of Higher Mathematics and Modeling

EDUCATIONAL PROGRAM

7M06105 - Cybernetics and artificial intelligence

(specialized direction – 2 years)

Code and Classification of Education Area: 7M06
Information and Communication Technology
Code and classification of areas of training: 7M061
Information and Communication Technologies
Group of educational programs: M094
Information Technology
NRC level: 7M
OPC level: 7
Study period: 2 years
Credit volume: 120

Almaty 2025

NAO "KAZAKH NATIONAL ISSUE TECHNICAL UNIVERSITY
K.I. SATPAYEV

Educational program 7M06105 – «Cybernetics and Artificial Intelligence» approved at the meeting of the Academic Council of KazNRTU named after K.I. Satpayev.
Protocol No.10 of "06" March 2025 year.

Considered and recommended for approval at the meeting of the Educational-Methodical Council of KazNRTU named after K.I. Satpayev.
Protocol No. 3 of "20" December 2024 year.

Educational program 7M06105 – «Cybernetics and Artificial Intelligence» developed by the academic committee for the direction 7M061 "Information and communication technologies".

Name and surname.	Degree Academic title	Position	Place of work	Sign
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F KazNITU 703-05 Educational program

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List of abbreviations and designations

EP - educational program,
LO - learning outcomes,
DG - Digital modeling,
IEP - individual educational plan

1. Description of the educational program

The educational program (EP) of higher professional education ensures the implementation of the state educational standard, taking into account the type of higher educational institution, educational needs and requests of students and includes a working curriculum, syllabuses (working programs of training courses), disciplines (modules) and other materials that ensure the quality of training of students.

The main idea of the educational program is to implement a continuous process of training a new generation of professional personnel capable of working to transform the new scientific potential of Kazakhstan from raw materials to innovation through the development and implementation of sustainable trends in the field of digital service and operational services.

The uniqueness of the EP "Cybernetics and Artificial Intelligence" is determined by the competencies that a master's student who has completed his education under this program possesses.

2. Goal and objectives of the educational program

Purpose of the EP: The curriculum program is created with the focus on training competitive professionals in computer science and information technologies, which will possess the valuable knowledge in such future technologies as artificial intelligence and hence will be distinguished on the international IT market. The goal of the educational program is to teach master's students basic and specialized disciplines with the achievement of relevant competencies. The goal of the educational program is the targeted training of specialists with valuable knowledge of the technologies of the future - artificial intelligence technologies, which will distinguish them favorably in the international IT services market. They will study the main methods of artificial intelligence using simple, "tangible" examples and show the mathematical basis of machine learning and artificial intelligence. The main task of this area is to model intellectual activity using computers.

Upon completion of the course, graduates will learn working machine learning algorithms to apply them to their tasks (theoretical or applied). The educational program involves mastering fundamental knowledge in mathematics and artificial intelligence. Graduates will have the opportunity to master almost all the skills necessary in the field of Data Science, Data Engineering, Quantitative Analysis (in Python and R languages).

The special feature of this master's program is the preparation of graduates capable of carrying out the following types of professional activities:

- production;
- organizational and managerial;
- production and technological.

Objects of professional activity.

Graduates of the program can realize themselves in the following types of professional activity:

secondary specialized educational institutions;

manufacturing enterprises;

professional activity in the field of computer programming; - specialist, leading specialist, leading engineer, programmer engineer in organizational and managerial organizations;

in design organizations as a developer of mathematical and computer models, mathematician-programmer;

Tasks of the OP:

Task 1: Study of the basics of constructing artificial intelligence systems, the features of their organization, functioning, life cycle, directions of development of artificial intelligence, development of students' competencies in designing and using modern intelligent systems in professional activities.

Task 2: Training highly qualified personnel capable of developing both computer and mathematical models for various applications in the context of the formation and development of the digital economy.

Task 3: Readiness of specialists to search for and obtain new information necessary for solving professional problems in the field of cybernetics and artificial intelligence.

Task 4: Prepare a product of human intellectual activity, study its structure, and strive to reproduce this product using modern technology.

Task 5: Readiness of specialists for self-training and continuous professional development throughout the entire period of their professional activity.

3. Requirements for assessing the learning outcomes of the educational program

List of competencies
General competencies

A graduate who has completed a Master's degree program must have the following general professional competencies:

- the ability to independently acquire, comprehend, structure and use new knowledge and skills in professional activities, and develop their innovative abilities;

– the ability to independently formulate research goals, establish a sequence for solving professional problems;

– the ability to apply in practice knowledge of fundamental and applied sections of disciplines that determine the focus (profile) of the master's program;

– the ability to professionally select and creatively use modern scientific and technical equipment to solve scientific and practical problems;

– the ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities;

– skills in compiling and formatting scientific and technical documentation, scientific reports, reviews, reports and articles; – readiness to lead a team in the field of their professional activity, tolerantly perceiving social, ethnic,

religious and cultural differences; – readiness to communicate orally and in writing in a foreign language to solve professional problems.

Professional competencies

A graduate who has completed a master's degree program must have professional competencies corresponding to the types of professional activity that the master's degree program is focused on:

– production activity:

– the ability to independently carry out production, field, laboratory and interpretation work in solving practical problems; – the ability to professionally operate modern field and laboratory equipment and devices in the field of the master's program;

– the ability to use modern methods of processing and interpreting complex information to solve production problems; – project activities: – the ability to independently draw up and present projects for research and development and scientific production work;

– readiness to design complex research and development and production work when solving professional problems; – organizational and managerial activities: – readiness to use practical skills in organizing and managing research and development and production work when solving professional problems;

- readiness for the practical use of regulatory documents in planning and organizing scientific and production work;

When developing a master's program, all general cultural and general professional competencies, as well as professional competencies related to the types of professional activity that the master's program is focused on, are included in the set of required results for mastering the master's program.

Learning outcomes

LO 1 - to know and understand modern trends, trends and patterns of development of domestic science in the context of globalization and internationalization; methodology of scientific knowledge; achievements of world and Kazakh science in the relevant field; (realize and accept) the social responsibility of science and education; perfect foreign language for scientific communication and international cooperation.

LO 2 - have the skills of a systematic understanding of the field of study and demonstrate the quality and effectiveness of the chosen scientific methods; participation in scientific events, fundamental scientific domestic and international projects; leadership management and team management; responsible and creative attitude to scientific and scientific-pedagogical activities.

LO 3 - be able to work with architectures that include open libraries of deep learning; be able to draw the right conclusions from comparing the results of theory and experiment, distinguish from practical problems their formulation for machine learning, work with modern software complexes for solving machine learning problems.
LO 4 - be able to develop mathematical models and apply them in scientific experiments using modern software, conduct theoretical and experimental studies of stochastic processes and systems.
LO 5 - be able to analyze the efficiency of performing tasks on a GPU and hybrid computing systems based on GPUs, to profile programs.
LO 6 Be able to apply technologies of intellectual analysis of electronic data arrays to solve specific practical problems.
LO 7 - possess professional knowledge for the analysis and synthesis of physical information in the field of quantum computing, basic quantum algorithms, capabilities, methods and systems of computer technology for physical theoretical and experimental research in this field, the main physical platforms for the implementation of quantum computing.
LO 8 - know the formulation of classification, clustering, forecasting problems, know algorithms and methods of deep learning.
LO 9 - be able to organize, plan and implement the process of scientific research; analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; analyze and process information from various sources.
LO 10 - be competent in matters of interpersonal communication and human resource management; in matters of university training of specialists; in conducting expertise of scientific projects and research; in ensuring continuous professional growth.
LO 11 - be able to conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis; generate their own new scientific ideas, communicate their knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge.
LO 12- be competent in the field of scientific and scientific-pedagogical activity in conditions of rapid updating and growth of information flows; in conducting theoretical and experimental scientific research; in setting and solving theoretical and applied problems in scientific research; in conducting professional and comprehensive analysis of problems in the relevant field.
LO 13- possess methods of numerical stochastic modeling for conducting theoretical and experimental studies, knowledge of stochastic analysis for evaluating the obtained research results.
LO 14 - have the skills of critical analysis, evaluation and comparison of various scientific theories and ideas; analytical and experimental scientific activities; planning and forecasting research results; public speaking and public speaking at international scientific forums, conferences and seminars; scientific writing and scientific communication; planning, coordination and implementation of research processes.

LO 15- know the concept of stochastic analysis of systems and methods of stochastic modeling, the use of stochastic analysis in the development of mathematical models and the study of various systems and processes.
LO 16- know the features of the architecture of graphics processors, the principles of the organization of hybrid computing systems based on graphics processors, classes of tasks suitable for effective execution on graphics processors.

Learning strategy

The strategy of the educational program "Cybernetics and Artificial Intelligence" is aimed at training highly qualified specialists with fundamental knowledge in the fields of natural science,

engineering mechanics and computer modeling for work in the field of high technologies, taking into account modern trends in the development of science in general and mathematical modeling in particular. During the training, special attention is paid to mastering by master's students:

demonstrate developing knowledge and understanding in the area of cybernetics and artificial intelligence studied, based on advanced knowledge in that area, in developing and/or applying ideas in the context of research;

apply knowledge, understanding and abilities professionally to solve problems in a new environment, in a broader interdisciplinary context;

collect and interpret information to form judgments taking into account social, ethical and scientific considerations;

clearly and unambiguously communicate information, ideas, conclusions, problems and solutions to both specialists and non-specialists;

learning skills necessary for independent further study in the studied area of cybernetics of artificial intelligence.

To achieve these goals, the structure of classes in almost all specialized disciplines includes both laboratory and practical classes, i.e. students’ theoretical knowledge is firmly reinforced by the skills of their practical application.

During the course of graduates' dissertations under the educational program, the main focus is on instilling in graduates the skills to independently or in a team develop physical or virtual models of complex mechanical, physical and biochemical processes and phenomena, create computer codes or apply modern software for their research.

Possession of fundamental knowledge in various fields and computer modeling skills will allow graduates to relatively easily integrate into the work process of almost any industry and quickly master a wide range of new technologies.

4. Passport of the educational program

4.1 General information

№	Field name	Note
1	Code and classification of the field of education	7M06 Information and Communication Technology
2	Code and classification of training areas	7M061 Information and Communication Technology
3	Group of educational programs	M094 Information Technology
4	Name of educational program	7M06105- Cybernetics and Artificial Intelligence
5	Brief description of the educational program	The educational program (EP) of higher professional education ensures the implementation of the state educational standard, taking into account the type of higher educational institution, educational needs and requests of students and includes a working curriculum, syllabuses (working programs of training courses), disciplines (modules) and other materials that ensure the quality of training of students. The main idea of the educational program is to implement a continuous process of training a new generation of professional personnel capable of working to transform the new scientific potential of Kazakhstan from raw materials to innovation through the development and implementation of sustainable trends in the field of digital service and operational services. The uniqueness of the EP "Cybernetics and Artificial Intelligence" is determined by the competencies that a master's student who has completed his education under this program possesses.
6	Purpose of the EP	Purpose of the EP: The goal of the educational program is to teach master's students basic and specialized disciplines with the achievement of relevant competencies. The goal of the educational program is the targeted training of specialists with valuable knowledge of the technologies of the future - artificial intelligence technologies, which will distinguish them favorably in the international IT services market. They will study the main methods of artificial intelligence using simple, "tangible" examples and

		show the mathematical basis of machine learning and artificial intelligence. The main task of this area is to model intellectual activity using computers. Upon completion of the course, graduates will learn working machine learning algorithms to apply them to their tasks (theoretical or applied). The educational program involves mastering fundamental knowledge in mathematics and artificial intelligence. Graduates will have the opportunity to master almost all the skills necessary in the field of Data Science, Data Engineering, Quantitative Analysis (in Python and R languages).
7	Type of EP	Master's Degree
8	NRC level	7M
9	Level on OCR	7
10	Distinctive features of the EP	The peculiarity of this master's program is the preparation of graduates capable of carrying out the following types of professional activity: - production; - organizational and managerial; - production and technological.
11	List of competencies of the educational program:	General competencies A graduate who has completed a Master's degree program must have the following general professional competencies: - the ability to independently acquire, comprehend, structure and use new knowledge and skills in professional activities, and develop their innovative abilities; – the ability to independently formulate research goals, establish a sequence for solving professional problems; – the ability to apply in practice knowledge of fundamental and applied sections of disciplines that determine the focus (profile) of the master's program; – the ability to professionally select and creatively use modern scientific and technical equipment to solve scientific and practical problems; – the ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities; – skills in compiling and formatting scientific and technical documentation, scientific reports, reviews, reports and articles; – readiness to lead a team in the field of their professional activity, tolerantly perceiving social, ethnic, religious and cultural differences; – readiness to communicate orally and in writing in a foreign language to solve professional problems. Professional competencies A graduate who has completed a master's degree program must have professional competencies corresponding to the types of

		professional activity that the master's degree program is focused on: – production activity: – the ability to independently carry out production, field, laboratory and interpretation work in solving practical problems; – the ability to professionally operate modern field and laboratory equipment and devices in the field of the master's program; – the ability to use modern methods of processing and interpreting complex information to solve production problems; – project activities: – the ability to independently draw up and present projects for research and development and scientific production work; – readiness to design complex research and development and production work when solving professional problems; – organizational and managerial activities: – readiness to use practical skills in organizing and managing research and development and production work when solving professional problems; - readiness for the practical use of regulatory documents in planning and organizing scientific and production work; When developing a master's program, all general cultural and general professional competencies, as well as professional competencies related to the types of professional activity that the master's program is focused on, are included in the set of required results for mastering the master's program.
12	Learning outcomes of the educational program:	LO 1 - to know and understand modern trends, trends and patterns of development of domestic science in the context of globalization and internationalization; methodology of scientific knowledge; achievements of world and Kazakh science in the relevant field; (realize and accept) the social responsibility of science and education; perfect foreign language for scientific communication and international cooperation. LO 2 - have the skills of a systematic understanding of the field of study and demonstrate the quality and effectiveness of the chosen scientific methods; participation in scientific events, fundamental scientific domestic and international projects; leadership management and team management; responsible and creative attitude to scientific and scientific-pedagogical activities. LO 3 - be able to work with architectures that include open libraries of deep learning; be able to draw the right conclusions from comparing the results of theory and experiment, distinguish from practical problems their formulation for machine learning, work with modern

		software complexes for solving machine learning problems. LO 4 - be able to develop mathematical models and apply them in scientific experiments using modern software, conduct theoretical and experimental studies of stochastic processes and systems. LO 5 - be able to analyze the efficiency of performing tasks on a GPU and hybrid computing systems based on GPUs, to profile programs. LO 6 Be able to apply technologies of intellectual analysis of electronic data arrays to solve specific practical problems. LO 7 - possess professional knowledge for the analysis and synthesis of physical information in the field of quantum computing, basic quantum algorithms, capabilities, methods and systems of computer technology for physical theoretical and experimental research in this field, the main physical platforms for the implementation of quantum computing. LO 8 - know the formulation of classification, clustering, forecasting problems, know algorithms and methods of deep learning. LO 9 - be able to organize, plan and implement the process of scientific research; analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; analyze and process information from various sources. LO 10 - be competent in matters of interpersonal communication and human resource management; in matters of university training of specialists; in conducting expertise of scientific projects and research; in ensuring continuous professional growth. LO 11 - be able to conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis; generate their own new scientific ideas, communicate their knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge. LO 12- be competent in the field of scientific and scientific-pedagogical activity in conditions of rapid updating and growth of information flows; in conducting theoretical and experimental scientific research; in setting and solving theoretical and applied problems in scientific research; in conducting

		professional and comprehensive analysis of problems in the relevant field. LO 13- possess methods of numerical stochastic modeling for conducting theoretical and experimental studies, knowledge of stochastic analysis for evaluating the obtained research results. LO 14 - have the skills of critical analysis, evaluation and comparison of various scientific theories and ideas; analytical and experimental scientific activities; planning and forecasting research results; public speaking and public speaking at international scientific forums, conferences and seminars; scientific writing and scientific communication; planning, coordination and implementation of research processes. LO 15- know the concept of stochastic analysis of systems and methods of stochastic modeling, the use of stochastic analysis in the development of mathematical models and the study of various systems and processes. LO 16- know the features of the architecture of graphics processors, the principles of the organization of hybrid computing systems based on graphics processors, classes of tasks suitable for effective execution on graphics processors.
13	Form of training	Full-time
14	Duration of training	2 years
15	Volume of credits	120
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree	Master of Engineering and Technology
18	Developer(s) and authors:	Lukpanova L.H., Tulesheva G.A.

4.2 Interrelation of achievability of the learning outcomes of the educational program and academic disciplines

№	Name of discipline	Brief description of the discipline	Number of credits	Formable learning outcomes (codes)															
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO 10	LO 11	LO 12	LO 13	LO 14	LO 15	LO 16
CYCLE OF BASIC DISCIPLINES (BD) **Module of basic training (university component)**																			
1	Foreign language (professional)	The course is aimed at studying the main problems of scientific knowledge in the context of its historical development and philosophical understanding, the evolution of scientific theories, principles and methods of scientific research in the historical construction of scientific paintings of the world. The discipline will help to master the skills of developing critical and constructive scientific thinking based on research on the history and philosophy of science. At the end of the course, undergraduates will learn to analyze the ideological and methodological problems of science and engineering and technical activities in building Kazakhstan's science and the prospects for its development.	3	v	v														

2	History and philosophy of science	Purpose: to explore the history and philosophy of science as a system of concepts of global and Kazakh science. Content: the subject of philosophy of science, dynamics of science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.	3	v							v	v			v				
3	Higher school pedagogy	The course is aimed at mastering the methodological and theoretical foundations of higher education pedagogy. The discipline will help to master the skills of modern pedagogical technologies, technologies of pedagogical design, organization and control in higher education, skills of communicative competence. At the end of the course, undergraduates learn how to organize and conduct various forms of organizing training, apply active teaching methods, and select the content of training sessions. Organize the educational process on the basis of credit technology of education.	3	v	v						v								

4	Psychology of management	The course is aimed at mastering the tools for effective employee management, based on knowledge of the psychological mechanisms of the manager's activity. Discipline will help you master the skills of making decisions, creating a favorable psychological climate, motivating employees, setting goals, building a team and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create their own image, analyze situations in the field of managerial activity, as well as negotiate, be stress-resistant and effective leaders.	3	v							v		v	v					
Cycle of basic disciplines Component of choice																			

5	Intellectual property and research	The purpose of this course is to provide undergraduates with the knowledge and skills necessary to understand, protect and manage intellectual property (IP) in the context of scientific research and innovation. The course is aimed at training specialists who can effectively work with IP, protect the results of scientific research and apply them in practice.	**5**	**v**											**v**		**v**		
6	Data mining	Objectives: to study modern methods and algorithms of visualization, systematization, research, analysis and forecasting of large-dimensional data, basic methods and algorithms of Data Mining, comparative analysis. Development of practical skills in the use of basic methods and algorithms of data mining; the ability to apply technologies of intellectual analysis of electronic data arrays to solve specific practical problems.	5		**v**	**v**			**v**										

7	Artificial neural networks	The purpose of mastering the discipline is to form students in the field of system analysis and management of theoretical knowledge and practical skills in the use of neural networks to solve classification problems. Considered: the history of the development of artificial neural networks; the main directions of the use of artificial neural networks; types of neural networks.	5			v					v	v							
8	Quantum computing	Objectives: formation of theoretical knowledge on the basic concepts, methods of the theory of quantum computing; development of skills, practical skills of construction, analysis of quantum circuits, calculation of probabilities in quantum measurements; study of quantum algorithms, information protocols. The course examines the main provisions of the classical theory of computational complexity, the gate model and algorithms of quantum computing.	5				v			v									

9	Machine learning methods	Objectives of the discipline: to form theoretical knowledge on the basics of machine learning for the construction of formal mathematical models and interpretation of modeling results; to develop skills in the practical application of machine learning methods for the construction of formal mathematical models and interpretation of modeling results in solving applied problems in various applied fields.	5						v							v		v	
10	Sustainable development strategies	Purpose: To train graduate students in sustainable development strategies to achieve a balance between economic growth, social responsibility, and environmental protection. Content: Graduate students will study the concepts and principles of sustainable development, the development and implementation of sustainable development strategies, the evaluation of their effectiveness, and international standards and best practices. Cases and examples of successful sustainable development strategies are included.	5	v													v		
CYCLE OF PROFILE DISCIPLINES (PD) Module of																			

		professional activity (university component,																
11	Machine learning theory	Purpose: to form the skills and abilities of creating intelligent control systems, pattern recognition, forecasting in all spheres of human activity. In the course, students get acquainted with the formulation of the learning task, data preparation, principles of learning, decision-making, approaches to the organization of training, validation of results, methods and algorithms for classification and clustering of data.	5	v				v										v
12	Python for deep machine learning	Objectives: familiarization with modern approaches to the construction, training and use of recognition and classification systems based on machine learning methods, the formation of professional competencies among undergraduates. The content is aimed at mastering algorithms and methods of deep learning – a special section in machine learning; the formation of skills and abilities in solving practical problems using deep learning methods.	5			v												v

13	Additional questions of the theory of stochastic processes	Objectives: the formation of masters' theoretical knowledge and practical skills on stochastic differential systems and modeling methods, the application of this knowledge in solving problems in research and production and technological processes. The student should know the methods of stochastic modeling, be able to apply stochastic analysis in the development of mathematical models, the study of systems and processes.	5				v									v		v	
14	Interfaces for multi-core systems	Objectives: formation of theoretical knowledge and practical skills in the use of modern computing systems, software tools for solving a wide range of tasks in various fields. The course examines the features of the architecture of GPUs, the principles of the organization of hybrid computing systems based on GPUs, classes of tasks suitable for efficient execution on GPUs.	5			v				v									

15	Mathematical statistics and stohastic processes	The course studies the regularities of random phenomena, a probabilistic approach to the construction of mathematical models of real events and processes in various classes of random functions, the formulation and solution of emerging mathematical problems. It also considers the formal mathematical apparatus of the theory of probability and random processes, the possibility of its use in the process of further education, the application of methods of probability theory and stochastic processes to analyze problems in various subject areas.	5													v		v	
16	Concept of cloud technology	The purpose of the course is to acquire knowledge and skills on the basics of parallel programming and parallel data processing. Objectives of the course: to teach methods of parallel information processing and representation of parallel algorithms; to form means of specification of parallel processes; to teach parallel programming languages; to master methods of automatic parallelization of sequential algorithms.	5					v										v	

17	Applied information theory	The purpose of mastering: formation of ideas about information theory as a universal language of science, a means of modeling phenomena and processes; development of logical thinking, spatial imagination, algorithmic culture, critical thinking at the level necessary for future professional activity, continuing education, self-education; mastering theoretical knowledge and skills necessary in everyday life to study related disciplines professional cycle.	5			v												v		
18	Modern problems of Partial Differential Equations	Objectives: to study modern methods of constructing and analyzing mathematical models that arise when solving natural science problems, methods of developing, implementing algorithms for solution. The course deals with the equations of transport, heat, wave, Laplace and their fundamental solutions, energy methods; theory for linear PDE; elliptic equations of the second order; theory of nonlinear PDE; non-variational methods; Hamilton-Jacobi equations.	5					v			v									

19	Theory of models	Purpose: to expand knowledge of the main sections of logic. The course examines the completeness and consistency theorem, the definition of complete and incomplete theory, model-complete theory, the concepts of submodel and elementary submodel, the concepts of type and the theorem on the implementation of type, the theorem on the omission of a countable type in a countable theory.	5				v	v											v
20	Partial differential equations on complex sets	Purpose: The course is based on the theory of ordinary and partial differential equations and mathematical analysis. Contents: Some modern principles for modeling mechanical systems consisting of a finite number of elements of different dimensions. Some methods of theoretical study of differential equations describing processes in layered media and methods of numerical analysis are presented. As a result of this course, students should gain some experience in modeling and investigating some complex mechanical systems.	4					v			v								

21	Machine Learning & Deep Learning	The course focuses on deep learning models. As a field within machine learning, deep learning models exemplify the quantitative-qualitative transition. New models and their properties require a separate study and practice of setting the metaparameters of such models. This course covers deep learning fundamentals, neural networks, convolutional networks, RNN, LSTM, Adam, Dropout, BatchNorm, Xavier/He initializations.	5			v													v

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 additional educational programs (Minor)