Federal State Autonomous Educational Institution of Higher Education
Peoples' Friendship University of Russia named after Patrice Lumumba

Academy of Engineering

(name of the main educational unit (MEU) that developed the educational program of higher education)

WORKING PROGRAM OF THE DISCIPLINE

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

(name of discipline/module)

Recommended for the field of study/specialty:

27.03.04 CONTROL IN TECHNICAL SYSTEMS

(code and name of the field of study/specialty)

The discipline is mastered within the framework of the implementation of the main professional educational program of higher education (EP HE):

DATA SCIENCE AND SPACE SYSTEMS

(name (profile/specialization) of the educational institution of higher education)

2026

1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Fundamentals of Artificial Intelligence" is part of the bachelor's program "Data Science and Space Systems" (27.03.04 "Control in Technical Systems") and is studied in the fourth semester of the second year. The course is offered by the Department of Mechanics and Control Processes. It consists of five sections and 13 topics and focuses on key areas of artificial intelligence, methods and information technologies used to solve professional problems, the fundamentals of developing algorithms for solving problems using machine learning, machine vision, and natural language processing, as well as their quality assessment.

The goal of this course is to provide students with the necessary knowledge to apply artificial intelligence methods and technologies in their professional activities, become familiar with machine learning algorithms, and assess the quality of solutions to machine learning, machine vision, and other artificial intelligence problems.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the course "Fundamentals of Artificial Intelligence" aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies developed in students while mastering the discipline (results of mastering the discipline)

Cipher	Competence	Indicators of Competency Achievement (within this discipline)
UC-11	Capable of forming an intolerant attitude towards manifestations of extremism, terrorism, and corrupt behavior and counteracting them in professional activities	UC-11.1 Analyzes current legal norms that ensure the fight against corruption, terrorism and extremism in various areas of life, and also knows ways to prevent corruption, extremism and terrorism in the course of professional activities; UC-11.2 Plans, organizes and conducts events within the framework of professional activities aimed at forming a civic position and preventing manifestations of extremism, terrorism and corruption in society; UC-11.3 Complies with the rules of public interaction based on compliance with current legislation and an intolerant attitude towards manifestations of extremism, terrorism and corruption in society;
UC-6	Able to manage one's time, build and implement a trajectory of self-development based on the principles of lifelong learning	UC-6.5 Analyzes the main opportunities and tools of continuous education in relation to one’s own interests and needs, taking into account conditions, resources, personal capabilities, stages of career growth, time perspective for the development of activities and the requirements of the labor market; UC-6.6 Defines the tasks of self-development, goals and priorities of professional growth; UC-6.7 Distributes tasks into long-, medium- and short-term ones with justification of their relevance and analysis of resources for their implementation;
GPC-5	Capable of solving problems of development of science, engineering and technology in the field of management in technical systems, taking into account the legal framework in the field of intellectual property	GPC-5.1 Knows the theoretical foundations of digital technologies, the basics of modeling objects of professional activity, the basics of data analysis and presentation of information; GPC-5.2 Able to solve problems of professional activity using existing methods of modeling, data analysis, and information presentation; GPC-5.3 Possesses skills in developing algorithms and computer programs suitable for practical application;

3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL INSTITUTION

Course "Fundamentals of Artificial Intelligence" refers to the mandatory part of block 1 “Disciplines (modules)” of the educational program of higher education.

As part of the higher education program, students also master other disciplines and/or practices that contribute to the achievement of the planned results of mastering the discipline "Fundamentals of Artificial Intelligence".

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of the planned results of mastering the discipline

Cipher	**Name of competence**	**Previous courses/modules, practical training***	**Subsequent disciplines/modules, practices***
UC-11	Capable of forming an intolerant attitude towards manifestations of extremism, terrorism, and corrupt behavior and counteracting them in professional activities		Research work / Scientific research work; Undergraduate Training; Jurisprudence;
UC-6	Able to manage one's time, build and implement a trajectory of self-development based on the principles of lifelong learning	History of Russia; Introduction to the Specialty; Fundamentals of Project Activities; Fundamentals of Engineering Economics and Management; Physical Education;	Research work / Scientific research work; Technological Training; Undergraduate Training; Philosophers;
GPC-5	Capable of solving problems of development of science, engineering and technology in the field of management in technical systems, taking into account the legal framework in the field of intellectual property	Theoretical Mechanics;	Research work / Scientific research work; Technological Training; Undergraduate Training; Automatic Control Theory; Analysis of Geoinformation Data;

* - filled in accordance with the competency matrix and the SUP EP HE

** - elective courses/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF EDUCATIONAL WORK

The total workload of the course "Fundamentals of Artificial Intelligence" is 2 credit units.

Table 4.1. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**
			4
Contact work, academic hours	*34*		*34*
Lectures (LC)	17		17
Laboratory work (LW)	0		0
Practical/seminar classes (SC)	17		17
Independent work of students, academic hours	*38*		*38*
Control (exam/test with assessment), academic hours	*0*		*0*
Total complexity of the discipline	**academic hours**	***72***	*72*
	credit	***2***	*2*

The total workload of the course "Fundamentals of Artificial Intelligence" is 2 credit units.

Table 4.2. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**
			4
Contact work, academic hours	*34*		*34*
Lectures (LC)	17		17
Laboratory work (LW)	0		0
Practical/seminar classes (SC)	17		17
Independent work of students, academic hours	*38*		*38*
Control (exam/test with assessment), academic hours	*0*		*0*
Total complexity of the discipline	**academic hours**	***72***	*72*
	credit	***2***	*2*

The total workload of the course "Fundamentals of Artificial Intelligence" is 2 credit units.

Table 4.3. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**academic hours		**Semester(s)**
			4
Contact work, academic hours	*34*		*34*
Lectures (LC)	17		17
Laboratory work (LW)	0		0
Practical/seminar classes (SC)	17		17
Independent work of students, academic hours	*38*		*38*
Control (exam/test with assessment), academic hours	*0*		*0*
Total complexity of the discipline	**academic hours**	***72***	*72*
	credit	***2***	*2*

5. CONTENT OF THE DISCIPLINE

Table 5.1. Content of the discipline (module) by types of academic work

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
Section 1	Artificial Intelligence: Application in Professional Activities	1.1	Definition of artificial intelligence	Artificial intelligence (AI) is defined as the ability of computer systems to perform tasks traditionally requiring human intervention (learning, decision-making, pattern recognition, and natural language understanding). The main approaches to creating AI are symbolic (logical), neural network (imitating the brain), and evolutionary. The concepts of strong and weak AI.	OK
		1.2	Intelligent applications for scientific research, manufacturing, enterprise management, quality management and business processes	AI applications in scientific research include big data analysis, pattern detection, and acceleration of computational experiments. In manufacturing, these applications include equipment failure prediction, optimization of operating modes, and product quality control. In enterprise management, these applications include demand forecasting, inventory optimization, and document automation. In quality management, these applications include automated defect detection and root cause analysis. In business processes, these applications include intelligent decision support systems and customer-facing chatbots.	LC, SC
		1.3	Modern methods of implementing artificial intelligence: the Internet of Things, recommender systems, data analysis, DigData, cloud technologies, additive technologies, virtual and augmented reality, blockchain	Internet of Things (IoT): collecting sensor data for intelligent analytics. Recommender systems: selecting products, content, and services based on user preferences. Data Mining: extracting hidden patterns from large data sets. Big Data: technologies for storing and processing extremely large volumes of information. Cloud technologies: providing computing resources and ready-made AI services via the internet. Additive technologies (3D printing): intelligent control of the printing process. Virtual and augmented reality: creating interactive environments with AI elements. Blockchain: distributed ledgers for ensuring trust in AI systems.	OK
		1.4	Software products	A review of software products and platforms for developing AI systems: machine learning libraries; neural network environments; computer vision platforms; natural language processing systems. Industrial AI platforms from leading companies. Examples of ready-made AI-based software solutions.	LC, SC
Section 2	Machine Learning Basics	2.1	Data processing	Data preparation stages for machine learning: data collection, cleaning (removing errors, outliers, and duplicates), normalization	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				(converting to a common scale), and encoding categorical features. Splitting data into training, validation, and test sets. The problem of class imbalance. Methods for handling missing values.	
		2.2	Model construction. Model quality assessment	Machine learning problem types: supervised learning (classification, regression), unsupervised learning (clustering, association rule mining), reinforcement learning. Model selection depending on the task. Training process: selecting model parameters based on the training set. Quality assessment: metrics for classification (precision, recall, F-score), for regression (mean absolute error, root mean square error). Concepts of overfitting (the model has learned the training data but generalizes poorly) and underfitting (the model is too simple). Validation and cross-validation.	LC, SC
		2.3	Application of machine learning models	The operational phase of a trained model: feeding new data to the model input, obtaining a forecast. The concept of inference. Speed and accuracy requirements in real-world systems. Monitoring model quality during operation (data drift, concept drift). Updating and retraining models.	LC, SC
Section 3	Machine vision	3.1	Machine vision in professional work. Image processing	Machine vision is defined as the ability of computers to "see" and interpret visual information. Applications include technical quality control, license plate and facial recognition, robot navigation, medical diagnostics, and security systems. Key tasks include object detection, image classification, segmentation (area extraction), and motion tracking. Image preprocessing includes filtering (noise reduction), contrast enhancement, binarization, and edge detection.	LC, SC
		3.2	Neural networks in machine learning	Artificial neural networks as a fundamental method of machine learning. The concept of a neuron (computational unit), weights, and activation functions. Multilayer networks (perceptrons). Convolutional neural networks: a key method for image processing (convolution, pooling, feature extraction). Examples of convolutional network architectures. Training neural networks: backpropagation, gradient descent.	LC, SC
Section 4	Natural language processing	4.1	Main tasks. Syntactic and morphological analysis	Natural language processing (NLP) is a field of AI that deals with the interaction of computers with human language. Key tasks include speech recognition (audio-to-text conversion), speech synthesis (text-to-audio), sentiment analysis, machine translation, question answering, and text summarization. Morphological anal-	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				ysis includes parsing words into morphemes, identifying parts of speech, case, and number. Syntactic analysis includes constructing the syntactic structure of sentences (dependency trees, phrase trees).	
		4.2	Neural networks for natural language processing	Recurrent neural networks (RNNs) and their modifications (LSTM – long short-term memory, GRU – supervised recurrent unit) for working with word sequences. Attention – highlighting important parts of the text. Transformers as a modern architecture for NLP (using models like BERT and GPT as examples). The concept of language models: predicting the next word in a sequence. Word embeddings – converting words into numerical vectors that reflect their meaning.	LC, SC
Section 5	Artificial intelligence technologies in industry	5.1	Intelligent automated and robotic systems	Intelligent control systems: adaptation to changing conditions, optimization of operating modes, and accident prediction. Industrial robots with AI elements: vision for object recognition, adaptive grasping, and learning by example. Collaborative robots (cobots) that work alongside humans. Autonomous vehicles (AGVs, driverless trucks) in manufacturing. Machine vision systems for product inspection and sorting.	LC, SC
		5.2	Additive technologies and simulation modeling	Adaptive technologies: systems that modify their behavior based on feedback and data analysis (adaptive machine control, material cutting optimization). Simulation modeling with elements of AI: agent-based modeling (the behavior of multiple independent agents), using machine learning to calibrate and accelerate simulations. Digital twins are virtual copies of production systems with elements of AI for prediction and optimization.	LC, SC

* - to be completed only for FULL-TIME education: LC – lectures; LW – laboratory work; SC – practical/seminar classes.

6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support for the discipline

Audience type	Equipment of the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	A lecture hall equipped with specialized furniture, a whiteboard (screen), and multimedia presentation equipment.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and technical means for multimedia presentations.	
For independent work	A classroom for independent student work (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	

* - the classroom for independent work of students MUST be indicated!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Shapiro L., Stockman J. Computer Vision: Textbook - BINOM, 2020. - 763 p. https://znanium.com/catalog/document?id=358712

2. Selyankin V.V. Computer vision. Image analysis and processing. – Lan Publishing House, 2021. – 152 pp. https://e.lanbook.com/book/173806

- Ostroukh A.V., Surkova N.E. Artificial Intelligence Systems. - Lan Publishing House, 2021. - 228 p. https://e.lanbook.com/book/176662

- Penkova T.G., Weinstein Yu.V. Models and methods of artificial intelligence: a tutorial. - Siberian Federal University, 2019. - 116 pp. https://e.lanbook.com/book/157579

Further reading:

1. Penkova T.G., Weinstein Yu.V. Models and methods of artificial intelligence: A tutorial. – Siberian Federal University, 2016. – 116 pp. https://e.lanbook.com/book/157579

2. Voronina V.V. Theory and Practice of Machine Learning: A Tutorial. – Ulyanovsk State Technical University, 2017. – 290 p. https://e.lanbook.com/book/165053

Resources of the information and telecommunications network "Internet":

1. RUDN University Electronic Library System and third-party electronic library systems to which university students have access based on concluded agreements

- RUDN University Electronic Library System – RUDN University Electronic Library System https://mega.rudn.ru/MegaPro/Web
- Electronic Library System "University Library Online" http://www.biblioclub.ru
- EBS "Urayt" http://www.biblio-online.ru
- Electronic Library System "Student Consultant" www.studentlibrary.ru
- EBS “Knowledge” https://znanium.ru/

2. Databases and search engines

- Sage https://journals.sagepub.com/
- Springer Nature Link https://link.springer.com/
- Wiley Journal Database https://onlinelibrary.wiley.com/
- Scientometric database Lens.org https://www.lens.org

3. arXiv A scientific journal featuring the latest advances in artificial intelligence https://arxiv.org

- System of organizing research competitions data https://www.kaggle.com
- Web service for hosting IT projects https://github.com
- matplotlib library https://matplotlib.org

Educational and methodological materials for independent work of students in mastering a discipline/module:*

1. Lecture course on the subject "Fundamentals of Artificial Intelligence".

* - all teaching and methodological materials for independent work of students are posted in accordance with the current procedure on the discipline page in TUIS!

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