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**Federal State Autonomous Educational Institution of Higher Education  
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA  
NAMED AFTER PATRICE LUMUMBA  
RUDN University**

**ACADEMY OF ENGINEERING**

(educational division (faculty/institute/academy) as programme developer)

**DEPARTMENT OF MECHANICS AND CONTROL PROCESSES**

(department realizing the PhD program)

## **COURSE SYLLABUS**

**Artificial intelligence and machine learning**

(course title)

Scientific specialty:

**1.2.1. Artificial intelligence and machine learning**

(scientific speciality code and title)

The course instruction is implemented within the PhD programmes:

**Artificial intelligence and machine learning**

(PhD program title)

## 1. DISCIPLINE (MODULE) GOAL

The goal of mastering the discipline “Artificial Intelligence and Machine Learning” is to develop in graduate students a system of scientific knowledge and professional competencies in the field of modern methods of system analysis, management and information processing.

## 2. REQUIREMENTS TO PHD-STUDENTS ON FINISHING THE COURSE

As a result of mastering the discipline “Artificial Intelligence and Machine Learning”, a graduate student must:

Know the basic modern methods for implementing program packages, modern scientific literature and journal articles in periodicals devoted to such problems.

Be able to identify current modern theoretical problems of system analysis, control and information processing and explain on this basis the existing facts and processes of development of approximate methods in modern mathematics.

Possess the skills of finding and comprehending new ones, as well as rethinking previously known facts, processes and trends that characterize the formation, evolution and transformation of system analysis, management and information processing in historical retrospect.

## 3. WORKLOAD OF THE DISCIPLINE AND TYPES OF ACTIVITIES

The total labor intensity of the discipline “Artificial Intelligence and Machine Learning” is 3 credit units.

*Table 3.1. Types of educational work for full-time education*

Type of educational activity		Total number of hours	Semester(s)
			3
Contact academic hours		30	30
Lectures (L)		30	30
Labwork (LW)			
Seminars (workshops/tutorials) (S)		30	30
Self-study(ies)		48	48
Evaluation and assessment (exam/pass/fail grading)			
Total labor intensity	h	108	108
	credits	3	3

## 4. CONTENT OF THE DISCIPLINE

*Table 4.1. Content of the discipline (module) by types of educational work*

Name of discipline section	Content of the section (topics)	Types of educational work
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Name of discipline section	Content of the section (topics)	Types of educational work
Section 1: Introduction to Artificial Intelligence	Introduction to artificial intelligence systems. The concept of artificial intelligence. The history of the development of the idea of artificial neural networks, machine learning and the place of these disciplines in science. Artificial intelligence in Russia. Functional structure of an artificial intelligence system. Directions for the development of artificial intelligence. Modern AI applications and main current trends. Data and knowledge. Representation of knowledge in intelligent systems.	L, S
Section 2: Machine Learning Terminology	Key AI terms. Basic problem statements: regression, classification, clustering, visualization. Learning from cases and training set. Quality metrics. Data types. Terminology: object, target variable, feature, quality metric, model, learning method. Examples of problem statements from psychology, economics, sociology, marketing, and jurisprudence. Analysis of specific formulations, characteristics, quality metrics for these tasks. Machine learning as a tool for automatically searching for patterns. Review of the main types of models and principles of their training (using simple examples). Linear models and text analysis, examples of analyzing reviews of banks	L, S

Name of discipline section	Content of the section (topics)	Types of educational work
	and job texts. Decision trees, decision forests and internet search engines. How search engines work. A culture of presenting data and conclusions in graphical form. Approaches and ideas about data visualization, demonstration of visualization examples.	
Section 3: Data Visualization	A culture of presenting data and conclusions in graphical form. Approaches and ideas about data visualization, demonstration of visualization examples.	<b>L, S</b>
Section 4. Problems and technologies of expert systems. Basics of Statistics	The concept of an expert system (ES). General characteristics of the ES. Types of ES and types of problems to be solved. Structure and modes of use of ES. Classification of ES tools and organization of knowledge in ES. Knowledge Engineering. The main tasks of a knowledge engineer. Intelligent information systems. Fundamentals of numerical data analysis and terminology - sample, population, mean, median, probability. Cases on data	<b>L, S</b>

Name of discipline section	Content of the section (topics)	Types of educational work
	analysis (Anscombe's Quartet, Titanic, Fisher's irises) and probabilistic problems (Monty Hall paradox). Peculiarities of interpretation of statistical indicators and patterns, false correlations and bimodal distributions	
Section 5. Neural networks. Futurism. Neuroscience and neuromarketing. Strong artificial intelligence concept	Terminology and architecture of neural networks and computational graphs. History of the development of the method, differences and similarities with biological neural networks, examples of solved problems and architectures. The foreseeable future of AI development is self-driving cars, smart voice assistants. The connection between neuroscience and AI, neuromarketing ideas. The concept of strong AI and the necessary steps to achieve this level of AI development. Application of neural networks. Training a neural network.	<b>L, S</b>
Section 6. Visual intelligence and computer vision	How computers see. RGB model. Apply basic computer vision concepts to create rules-based applications. Use cases for computer vision in real life. Thresholding, masks and points of interest. Geometric transformation, resizing and cropping. Basic image processing techniques using OpenCV and Python. Application of a combination of basic methods to solve	<b>L, S</b>

Name of discipline section	Content of the section (topics)	Types of educational work
	<p>problems in the field of computer vision. Advantages of using artificial intelligence in conjunction with computer vision. Convolutional architectures for image analysis: idea and analogy with automatic filter construction for Photoshop. Analysis of problem statements for understanding visual data: finding objects in photographs, determining age and gender from photographs, searching for visually pleasing photographs.</p> <p>Hidden Image Views</p>	
Section 7. Use of artificial intelligence to solve problems of processing and interpreting research data	<p>Artificial intelligence as an aid in calculating content analysis data and discourse analysis of texts (newspapers, websites, etc.) for the purpose of analyzing the social environment. Recurrent neural networks for sequence analysis. Hidden representations of words: idea, properties (closeness of representations, arithmetic operations). Speech recognition and speech-to-text conversion. Visual intelligence. Autoencoders for learning latent representations without labeling, their application for generating images of a certain class. Generating text descriptions from images. Generating images based on text descriptions.</p>	<b>L, S</b>

<b>Name of discipline section</b>	<b>Content of the section (topics)</b>	<b>Types of educational work</b>
Section 8. Practical application of artificial intelligence in solving professional problems	Prospects for the development of artificial intelligence in the field of big data analysis, decision support, and solving optimal control problems. The use of artificial intelligence and machine learning technologies in scientific research: diagnosis, analysis, interpretation and visualization of research results.	<b>L, S</b>

## **5. EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS**

*Table 5.1. Material and technical support of the discipline*

<b>Audience type</b>	<b>Audience equipment</b>	<b>Specialized educational / laboratory equipment, software and materials for mastering the discipline (if needed)</b>
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	The individual workplace of a graduate student must be equipped with a personal device with Internet access. A mobile phone is not a device capable of technically providing access to all information resources and services for mastering the modules. Computer classes/auditoriums must be equipped with multimedia and computer equipment with Internet access.
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	
Computer class	Computer class for conducting classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with personal computers (5 pcs.), a whiteboard (screen) and technical means for multimedia presentations.	
For independent work of students	Auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to EIOS.	

## 6. EDUCATIONAL-METHODOLOGICAL AND INFORMATIONAL SUPPORT OF DISCIPLINE

### *Main literature:*

1. Yang, E. S. Computer vision programming in Python / E. S. Yang; translation from English by A. A. Slinkin. - Moscow: DMK Press, 2016. - 312 p. — ISBN 978-5-97060-200-3. — Text: electronic // Lan: electronic library system. — URL: <https://e.lanbook.com/book/93569> (access date: 10/28/2023). — Access mode: for authorization. users.
2. Gruzdev, A. V. Studying Pandas / A. V. Gruzdev, M. Heydt; translation from English by A. V. Gruzdeva. — 2nd ed., revised. and additional — Moscow: DMK Press, 2019. — 700 p. — ISBN 978-5-97060-670-4. — Text: electronic // Lan: electronic library system. — URL: <https://e.lanbook.com/book/131693> (access date: 10/28/2023). — Access mode: for authorization. users.
3. Gruzdev, A. V. Predictive modeling in IBM SPSS Statistics, R and Python: decision tree method and random forest: a guide / A. V. Gruzdev. — Moscow: DMK Press, 2018. — 642 p. — ISBN 978-5-97060-539-4. — Text: electronic // Lan: electronic library system. — URL: <https://e.lanbook.com/book/123700> (access date: 10/28/2023). — Access mode: for authorized users.
4. Bonzanini, M. Social media analysis in Python. Extract and analyze data from all corners of the social web in Python / M. Bonzanini; translation from English by A. V. Logunov. — Moscow: DMK Press, 2018. — 288 p. — ISBN 978-5-97060-574-5. — Text: electronic // Lan: electronic library system. — URL: <https://e.lanbook.com/book/108129> (access date: 10/28/2023). — Access mode: for authorization. users.

### *additional literature*

5. Bobenko A.I., Suris Yu.B. Discrete differential geometry. Integrated structure - M.; Izhevsk: Research Center "Regular and Chaotic Dynamics": Izhevsk Institute of Computer Research, 2010. - 448 p.

6. Samarsky A. A., Vabishchevich P. N. Numerical methods for solving inverse problems of mathematical physics: Textbook. - M.: Publishing house LKI, 2014. - 480 p.

7. Naats V.I., Naats I.E. Mathematical models and numerical methods in problems of environmental monitoring of the atmosphere: Monograph - M.: FIZMATLIT, 2010. - 328 p.

### *Resources of the information and telecommunications network "Internet":*

1. EBS of RUDN University and third-party EBS, to the materials of which graduate students of the university have access on the basis of concluded agreements:

- Electronic library system of RUDN - EBS RUDN <http://lib.rudn.ru/MegaPro/Web>

- EBS "University Library Online" <http://www.biblioclub.ru>

- EBS - "Educational platform Urayt" <http://www.biblio-online.ru>



- EBS “Student Consultant” [www.studentlibrary.ru](http://www.studentlibrary.ru), integrated into the EBS of RUDN University

- EBS "Lan" <http://e.lanbook.com/>

- EBS “Troitsky Bridge”, integrated into the EBS of RUDN University

- EBS BOOKUP - professional medical literature <http://books-up.ru/>

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## 2. Databases\*

\* information about universal and specialized information bases for selection and inclusion in the program must be taken from the UNIBC (NB) website, link to the section <https://lib.rudn.ru/8>

- SCOPUS - scientometric, abstract database with organized access to open access publications <http://www.elsevierscience.ru/products/scopus/>

- WOS - scientometric, abstract database with organized access to open access publications [webofscience.com](http://webofscience.com)

- Google Scholar - <https://scholar.google.ru/>

- NEB, RSCI on the eLibrary.ru platform - <https://elibrary.ru/>

- RUDN Repository - <https://repository.rudn.ru/>

## 3. search engines:

- electronic fund of legal and regulatory technical documentation

<http://docs.cntd.ru/>

- Yandex search engine <https://www.yandex.ru/>

- Google search engine <https://www.google.ru/>

Educational and methodological materials for students' independent work when mastering a discipline/module.

All educational and methodological materials for students' independent work are posted in accordance with the current procedure on the discipline page in TUIS!

## **7. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR MIDTERM ATTESTATION OF STUDENTS IN THE DISCIPLINE (MODULE)**

Assessment toolkit and a grading system to evaluate the level of competences (competences in part) formation as the course results are specified on the TUIS platform.

## **DEVELOPERS:**

**Professor of DMCP**

position, educational department

**A.Yu. Alekseev**

signature

name and surname

**Professor of DMCP**

position, educational department

**I.V. Stepanyan**

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**HEAD OF EDUCATIONAL DEPARTMENT:**

**Head of DMCP**

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**Yu.N. Razoumny**

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