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**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

PYTHON FOR DATA SCIENCE

(name of discipline/module)

Recommended for the field of study/specialty:

27.04.04 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):

Artificial Intelligence, Machine Learning, and Space Science

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

1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Python for Data Science" is part of the Master's program "Artificial Intelligence, Machine Learning and Space Sciences" in the direction 27.04.04 "Control in Technical Systems" and is studied in the first semester of the first year. The course is implemented by the Department of the Partner University. The course consists of 4 sections and 11 topics and is aimed at studying - features of the Python language for data analysis, principles of reading various data; - Python libraries containing a large number of tools: from fast operations with multidimensional arrays to visualization and implementation of various mathematical methods, including linear algebra as the main mathematical apparatus for working with data; - optimization methods as the best tool for determining the optimal system parameters; - matrix decompositions, which are used in constructing regression models to reduce the dimensionality of data, in recommender systems and in text analysis; - basic concepts of probability theory and statistics, which are necessary for understanding the mechanism of operation of almost all data analysis methods.

The goal of this course is to familiarize students with the basics of working with the Python language in data analysis, and to expand their theoretical and practical training in the fields of mathematical analysis, linear algebra, optimization methods, and probability theory.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering Python for Data Science 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)
GPC-6	Capable of collecting and analyzing scientific and technical information, generalizing domestic and foreign experience in the field of automation and control equipment	GPC-6.1 Knows the basic methods of collecting and analyzing scientific and technical information; GPC-6.2 Able to analyze and generalize domestic and foreign experience in the field of automation and control equipment; GPC-6.3 Has knowledge of methods for collecting and analyzing scientific and technical information, and can also generalize domestic and foreign experience in the professional field;
GPC-8	Able to select methods and develop control systems for complex technical objects and technological processes	GPC-8.1 Knows the basic methods used to develop control systems for complex technical objects and technological processes; GPC-8.2 Able to develop control systems for complex technical objects and technological processes; GPC-8.3 Has skills in selecting methods and developing control systems for complex technical objects and technological processes;

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

Python for Data Science 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 "Python for Data Science".

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*
GPC-6	Capable of collecting and analyzing scientific and technical information, generalizing domestic and foreign experience in the field of automation and control equipment		Technology Threats and Cybersecurity Systems; Inferential Statistics; Research work / Scientific research work (acquiring primary skills in scientific research work); Undergraduate practice / Pre-graduation practice; Research Work;
GPC-8	Able to select methods and develop control systems for complex technical objects and technological processes		Undergraduate practice / Pre-graduation practice; Blockchain Technology;

* - 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 "Python for Data Science" course is 4 credits.

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)
			1
<i>Contact work, academic hours</i>	34		34
Lectures (LC)	17		17
Laboratory work (LW)	17		17
Practical/seminar classes (SC)	0		0
<i>Independent work of students, academic hours</i>	74		74
<i>Control (exam/test with assessment), academic hours</i>	36		36
Total complexity of the discipline	academic hours	144	144
	credit	4	4

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	Introduction	1.1	Cycles, functions, generators, list comprehension.	Loops (for, while) for organizing repetitive calculations. Functions: definition, call, arguments, return values. Generators for lazy evaluation and efficient work with large amounts of data. List comprehensions as a compact way to create lists.	LC, LW
		1.2	Functions and their properties. Limit and derivative.	Functions and their basic properties: domain, range, monotonicity, and extrema. The concept of the limit of a function. The concept of the derivative of a function as the rate of change. The mechanical and geometric meaning of the derivative.	LC, LW
		1.3	Geometric meaning of the derivative.	Geometric interpretation of the derivative: the slope of the tangent to the graph of a function at a given point. The equation of the tangent. The relationship between the sign of the derivative and the increase and decrease of the function.	LC, LW
Section 2	Python Libraries and Linear Algebra	2.1	Pandas. Data Frame. NumPy, SciPy and Matplotlib.	Pandas library: Series and DataFrame data structures for storing and processing tabular data. NumPy library: working with multidimensional arrays, vector and matrix operations. SciPy library: scientific computing, modules for optimization, integration, and signal processing. Matplotlib library: building static, animated, and interactive visualizations.	LC, LW
		2.2	Solving optimization problems in SciPy.	Solving optimization problems using SciPy modules (scipy.optimize). Finding the minimum and maximum of functions of one and several variables. Accounting for constraints in optimization problems (equalities and inequalities).	LC, LW
		2.3	Systems of linear equations. Matrix operations. Rank and determinant	Solving systems of linear algebraic equations (SLAEs) using NumPy and SciPy. Basic matrix operations: addition, multiplication, transposition, and matrix inverse. The concept of matrix rank (the maximum number of linearly independent rows or columns). The determinant of a matrix and its geometric meaning.	LC, LW
Section 3	Optimization and matrix factorizations	3.1	Partial derivatives and gradient. Tangent plane and linear approximation.	Partial derivatives of functions of several variables: definition and computational meaning. The gradient of a function as a vector of partial derivatives. The tangent plane to the surface of a function of two variables. Linear approximation of a function in the neighborhood of a point using the gradient.	LC, LW
		3.2	Optimization of nonsmooth functions. Sim-	Optimization of functions without a continuous derivative. Sim-	LC, LW

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
			ulated annealing method.	ulated annealing as a probabilistic global optimization method. Analogy with the annealing process in metallurgy: a gradual reduction in "temperature" to escape local minima.	
		3.3	Genetic algorithms and differential evolution. Nelder-Mead. Approximation by a matrix of lower rank.	Genetic algorithms: principles of natural selection, crossover, and mutation to find optimal solutions. Differential evolution as an optimization method for complex multidimensional problems. The Nelder-Mead method (simplex method) for unconstrained optimization without calculating derivatives. Matrix approximation: reducing the dimensionality of data while preserving the underlying structure (approximation).	LC, LW
Section 4	Accident	4.1	Randomness in probability theory and statistics. Properties of probability.	The concept of randomness as a fundamental category of probability theory. Properties of probability: non-negativity, normalization to unity, additivity for mutually exclusive events. Random events, the space of elementary outcomes.	LC, LW
		4.2	Conditional Probability. Estimating Distributions from a Sample. Important Characteristics of Distributions. Central Limit Theorem. Confidence Intervals.	Conditional probability is the probability of one event given the occurrence of another. Estimating the distribution of a random variable based on sample data. Key characteristics of distributions: mathematical expectation (mean), variance (measure of dispersion), and standard deviation. Central limit theorem: When summing a large number of independent random variables, their distribution tends toward normality. Confidence intervals: interval estimates of an unknown parameter with a given reliability.	LC, LW

* - 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.	
Computer class	A computer room for conducting classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with personal computers (in the amount of ____ units), a board (screen) 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. Muddana AL, Vinayakam S. Python for Data Science. – Springer, 2024. –P. 1-378.
2. Chevallier A. et al. Python for data science:dis. – Trivedi Center for Political Data (TCPD) Ashoka University, 2017.

Further reading:

1. Python W. Python //Python releases for windows. – 2021. –T. 24.
2. Van Rossum G., Drake FL An introduction to Python. – Bristol: Network Theory Ltd., 2003. –P. 115.

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>

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

1. Lecture course on the subject "Python for Data Science".

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

DEVELOPER:

Associate Professor

Position, DEPARTMENT

Signature

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HEAD OF THE DEPARTMENT:

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