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

DESIGN AND ANALYSIS OF ALGORITHMS
(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)

2026

1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Design and Analysis of Algorithms" is part of the Master's program "Artificial Intelligence, Machine Learning, and Space Sciences" in the 27.04.04 "Control in Technical Systems" program and is studied in the first semester of the first year. The course is offered by the department of the partner university. It consists of seven sections and eight topics and is aimed at exploring algorithmization to develop the ability and readiness to effectively construct and analyze algorithms in future professional activities.

The purpose of mastering the discipline is to study the basic methods of constructing and analyzing algorithms for solving applied and research problems; to gain experience in the practical application of knowledge to solve applied and research problems.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Creation and analysis of algorithms" 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-6	Able to identify and implement priorities for one's own activities and ways to improve them based on self-assessment	UC-6.1 Controls the amount of time spent on specific activities; UC-6.2 Develops tools and methods for time management when completing specific tasks, projects, and goals; UC-6.3 Analyzes one's resources and their limits (personal, situational, temporary, etc.) for the successful completion of the assigned task; UC-6.4 Distributes tasks into long-, medium- and short-term ones with justification of their relevance and analysis of resources for their implementation;
GPC-2	Able to formulate control problems in technical systems and justify methods for solving them	GPC-2.1 Knows the basic methods of solving control problems in technical systems; GPC-2.2 Able to justify methods for solving control problems in technical systems; GPC-2.3 Proficient in methods of setting control problems in technical systems;
GPC-3	Capable of independently solving control problems in technical systems based on the latest advances in science and technology	GPC-3.1 Knows the basic approaches to solving control problems in technical systems; GPC-3.2 Able to apply basic approaches based on the latest achievements of science and technology to solving control problems in technical systems; GPC-3.3 Proficient in methods of solving control problems in technical systems based on the latest achievements of science and technology;
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 EDUCATIONAL INSTITUTION

Course "Creation and Analysis of Algorithms" 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 "Creation and analysis of algorithms".

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-6	Able to identify and implement priorities for one's own activities and ways to improve them based on self-assessment		Undergraduate practice / Pre-graduation practice;
GPC-2	Able to formulate control problems in technical systems and justify methods for solving them		Undergraduate practice / Pre-graduation practice;
GPC-3	Capable of independently solving control problems in technical systems based on the latest advances in science and technology		Advanced Methods of Space Flight Mechanics; Undergraduate practice / Pre-graduation practice; Research work / Scientific research work (acquiring primary skills in scientific 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 course “Creation and analysis of algorithms” is 3 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)**
			1
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	*74*		*74*
Control (exam/test with assessment), academic hours	*0*		*0*
Total complexity of the discipline	**academic hours**	***108***	*108*
	credit	***3***	*3*

5. CONTENT OF THE DISCIPLINE

*Table 5.1. Content of the discipline (module) by type of*educational work

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
Section 1	Introduction.	1.1	Subject of the course: analysis of the quality of algorithms and development of methods for constructing efficient algorithms	Goals and objectives of the course. Key concepts: algorithm, computational process, algorithm correctness and efficiency. Algorithm quality criteria. Approaches to developing effective algorithmic solutions. The role of algorithm analysis in modern computing systems.	LC, SC
Section 2		2.1	Complexity measures. Time and capacity complexity	The concept of computational complexity of an algorithm. Time complexity as a function of input data size. Capacity (volume) complexity: estimating memory consumption. Classification of algorithms by complexity: polynomial, exponential, logarithmic, and others. The concept of asymptotic complexity. Best-case, worst-case, and average complexity estimates.	LC, SC
Section 3		3.1	Computing models	Random access memory machine (RAM model). Interleaved memory access model. The impact of the choice of computing model on algorithm complexity analysis. Comparison of various models. Parallel and distributed computing models.	LC, SC
Section 4		4.1	Mathematical foundations of algorithm analysis.	Elements of combinatorics and probability theory in algorithm analysis. Asymptotic notations: characteristics and purpose. Recurrence relations and methods for their solution (iterative method, master theorem). Summation of series and estimation of function growth. Expected running time of probabilistic algorithms.	LC, SC
Section 5		5.1	Data structures for representing some mathematical objects.	Selecting a data structure based on the problem being solved. Set representation: bit vectors, hash tables. Graph representation methods: adjacency matrix, adjacency list, incidence matrix. Optimal representation of sparse and dense matrices. The impact of data structure choice on the computational complexity of an algorithm.	LC, SC
Section 6		6.1	Tree data structure for the UNION FIND problem	Statement of the Union-Find (Disjoint Set Union) problem. Basic operations: searching a set by an element and merging two sets. Tree representation of disjoint sets. Optimization using heuristics: union by rank and path compression. Time complexity analysis of the resulting algorithm. Examples of practical application.	LC, SC
Section 7		7.1	Sorting data. Internal sorting (of arrays)	Sorting problem definition. Classification of sorting methods. Quadratic algorithms: bubble sort, insertion sort, selection sort. Efficient algorithms: quicksort, merge sort, heapsort. Counting sort	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				and other linear algorithms for special data types. Comparative analysis of time and space complexity. Stability of sorting algorithms.	
		7.2	External sorting (of sequences)	External memory management. External sorting performance criteria: number of external storage accesses. Serial data organization. Multiphase sorting. Balanced multiway merge. Selecting the batch size and memory buffers. External sort complexity assessment. Application of external sorting in database management systems.	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. Kozen DC The design and analysis of algorithms. – Springer Science & Business Media, 2012.

2. Alsuwaiyel MH Algorithms: design techniques and analysis. – World Scientific, 2021. –T. 15.

Further reading:

1. Du DZ, Ko KI, Hu X. Design and analysis of approximation algorithms. – Springer Science & Business Media, 2011. –T. 62.

2. Santoro N. Design and analysis of distributed algorithms. – John Wiley & Sons, 2006.

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 Yurayt 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 "Creation and analysis of algorithms".

* - 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:

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