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

OPERATIONS RESEARCH AND OPTIMIZATION TECHNIQUES
(name of discipline/module)

Recommended for the field of study/specialty:

27.04.04 CONTROL IN TECHNICAL SYSTEMS
(code and name of the training area/specialty)

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

AIML and Space Sciences / Artificial Intelligence, Machine Learning and Space Sciences
(name (profile/specialization) of the educational institution of higher education)

2025

1. THE GOAL OF MASTERING THE DISCIPLINE

The discipline "Operations Research and Optimization Techniques" 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 2nd semester of the 1st year. The discipline is implemented by the Department of the Partner University. The discipline consists of 6 sections and 15 topics and is aimed at studying the information approach to data models; modern technologies for decision-making, analysis of systems and situations, mastering the main ideas, methods, features of the areas of application and methods of using them as a ready-made tool for practical work in the design and development of systems, mathematical data processing, construction of algorithms and organization of computing processes on computer equipment; the formation of the necessary moral, ethical and professional qualities of developers and users of information systems.

The purpose of mastering the discipline is to develop students' theoretical knowledge and practical skills on issues related to making management decisions; mastering by graduates modern mathematical methods of analysis, scientific forecasting, teaching students to apply models and methods of operations research in the process of preparing and making management decisions.

2. REQUIREMENTS TO THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Operations Research and Optimization Techniques" is 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 Competence Achievement (within the framework of this discipline)
GPC-7	Capable of making informed choices, developing and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems	GPC-7.1 Able to develop and implement in practice circuit and system engineering solutions for automation and control systems; GPC-7.2 Can develop hardware and software solutions for automation and control systems; GPC-7.3 Possesses approaches for making a well-founded choice and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems;
GPC-9	Capable of developing methods and performing experiments on existing facilities with processing of results based on information technologies and technical means	GPC-9.1 Possesses modern information technologies and technical means for conducting experiments at operating facilities; GPC-9.2 Has skills in developing methods and conducting experiments at existing facilities; GPC-9.3 Has the skills to develop methods and perform experiments at existing facilities with processing of results using information technology;
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under study in the field of aerospace systems management	PC-2.1 Knows modern theoretical and experimental methods used to develop mathematical models of the objects under study and processes of professional activity; PC-2.2 Able to determine the effectiveness of the methods used to develop mathematical models of the objects and processes under study; PC-2.3 Has mastered modern theoretical and experimental methods for developing mathematical models of objects and processes of professional activity in the field of study;

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

Discipline "Operations Research and Optimization Techniques" 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 "Operations Research and Optimization Techniques".

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, practices***	**Subsequent disciplines/modules, practices***
GPC-7	Capable of making informed choices, developing and implementing in practice circuit, system engineering and hardware-software solutions for automation and control systems		Undergraduate practice / Pre-graduation practice;
GPC-9	Capable of developing methods and performing experiments on existing facilities with processing of results based on information technologies and technical means	Introduction to Geospatial Technology;	Undergraduate practice / Pre-graduation practice; Dynamics and Control of Space Systems; Geoinformation Systems and Applications;
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under study in the field of aerospace systems management	Mathematics for Spatial Sciences;	Undergraduate practice / Pre-graduation practice; Research Work; Dynamics and Control of Space Systems; *Artificial Neural Networks (Deep Learning)***; *Artificial Neural Networks (Deep Learning)***; Advanced Methods of Space Flight Mechanics; *Artificial Neural Networks (Reinforcement Learning)***;

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

** - elective disciplines/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF STUDY WORK

The total workload of the discipline “Operations Research and Optimization Techniques” is “4” 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,**ac.h.		**Semester(s)**
			2
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	*83*		*83*
Control (exam/test with assessment), academic hours	*27*		*27*
General complexity of the discipline	**ac.h.**	***144***	*144*
	credit.ed.	***4***	*4*

5. CONTENT OF THE DISCIPLINE

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

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
Section 1	Basics of Linear Programming	1.1	Basic concepts of operations research. Forms of recording linear programming problems.	LC
		1.2	Graphical method for solving linear programming problems	
		1.3	Basic concepts of operations research.	
Section 2	Applied optimization methods for solving linear programming problems	2.1	Simplex method	SC
		2.2	Duality in Linear Programming	
		2.3	Analysis of the stability of the optimal solution	
		2.4	Linear programming transportation problem	
Section 3	Integer programming	3.1	Gomori's cutting methods	
		3.2	Reducing a matrix game to a linear programming problem	
Section 4	Matrix game theory	4.1	Basic concepts of matrix game theory	
		4.2	Reducing a matrix game to a linear programming problem	
Section 5	Dynamic programming	5.1	Statement of the dynamic programming problem	
		5.2	Functional method	
Section 6	Nonlinear programming	6.1	Lagrange multiplier method	
		6.2	Quadratic programming	

* - filled in 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 of the discipline

Audience type	Equipping the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means for multimedia presentations.	
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 work of students (can be used for conducting seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	

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

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. KuLCarni AJ, Satapathy SC (ed.). Optimization in machine learning and applications. – Heidelberg: Springer, 2020. – pp. 51-68.

2. Sra S., Nowozin S., Wright S. J. (ed.). Optimization for machine learning. – MIT press, 2011.

Further reading:

1. Haidar AD Operations research and optimization techniques //Construction Program Management–Decision Making and Optimization Techniques. – Cham: Springer International Publishing, 2015. – pp. 131-157.

2. Lan G. First-order and stochastic optimization methods for machine learning. – Cham: Springer, 2020. – T. 1.

Resources of the information and telecommunications network "Internet":

1. RUDN University EBS and third-party EBSs to which university students have access on the basis of concluded agreements
   - Electronic library system of RUDN - ELS RUDN https://mega.rudn.ru/MegaPro/Web
   - Electronic library system "University library online"http://www.biblioclub.ru
   - EBS "Yurait"http://www.biblio-online.ru
   - Electronic Library System "Student Consultant" www.studentlibrary.ru
   - EBS "Znanium"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 “Operations Research and Optimization Techniques”.

* - all educational 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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