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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 academic unit (MAU)-developer of the HEI)

## **WORKING PROGRAM OF DISCIPLINE**

### **MODERN REMOTE SENSING TECHNIQUES AND GEOGRAPHIC INFORMATION SYSTEMS**

(name of discipline/module)

**Recommended by ISSC for the direction of training/specialization:**

#### **01.04.02 APPLIED MATHEMATICS AND INFORMATICS**

(code and name of training direction/specialty)

**The mastering of the discipline is carried out within the framework of the implementation of the basic professional educational program of higher education:**

#### **BALLISTIC DESIGN OF SPACE COMPLEXES AND SYSTEMS**

(name (profile/specialization) of HEI)

**2024 г.**

## 1. PURPOSE OF MASTERING THE DISCIPLINE

The discipline "Advanced Methods of Remote Sensing and Geoinformation Systems" is part of the Master's program "Ballistic Design of Space Complexes and Systems" in the direction 01.04.02 "Applied Mathematics and Informatics" and is studied in the 2nd semester of the 1st year. The discipline is realized by the Department of Mechanics and Control Processes. The discipline consists of 7 sections and 12 topics and is aimed at studying the latest software allowing to use the achievements of space activity results (SAR), the formation of special professional competencies associated with the possibility of using innovative methods of management in solving applied problems

The purpose of mastering the discipline is to form fundamental knowledge and skills of application of methods of solving problems necessary for professional activity, increase the general level of students' literacy on geoinformation systems

## 2. REQUIREMENTS TO THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Modern remote sensing methods and geoinformation systems" is aimed at the formation of the following competences (parts of competences) in students:

*Table 2.1. List of competences formed by students in the course of mastering the discipline (results of mastering the discipline)*

<b>Cipher</b>	<b>Competence</b>	<b>Indicators of competence achievement (within the discipline)</b>
GC-1	Able to critically analyze problem situations on the basis of a systematic approach, develop a strategy of action	GC-1.1 Analyzes a task, identifying its basic components;; GC-1.2 Identifies and ranks information required to solve a problem;; GC-1.3 Searches for information to solve a given problem using various types of queries;; GC-1.4 Proposes options for solving a problem and analyzes the possible consequences of using them;;
GC-7	Able to search for necessary sources of information and data, to perceive, analyze, remember and transfer information using digital means, as well as with the help of algorithms when working with data received from various sources in order to effectively use the obtained information to solve problems; to evaluate information, its reliability, to build logical inferences on the basis of incoming information and data	GC-7.1 Locates appropriate sources of information and data, perceives, analyzes, remembers, and communicates information using digital tools and algorithms when working with data obtained from various sources to effectively use the information obtained to solve problems;; GC-7.2 Evaluates information, its reliability, draws logical inferences from incoming information and data;
PC-1	Able to formulate goals, objectives of scientific research in the field of applied mathematics and computer science, computer science and modern programming technologies, select methods and means of problem solving	PC-1.1 Possesses fundamental knowledge acquired in mathematical and/or natural sciences, programming and information technology;; PC-1.2 Can find, formulate and solve standard problems in his/her own research activities in the field of applied mathematics and computer science, computer science and modern programming technologies;; PC-1.3 Has practical experience in research activities in applied mathematics and computer science, computer science and modern programming technologies...;
PC-2	Able to apply modern theoretical and experimental methods of development of mathematical	PC-2.1 Knows modern theoretical and experimental methods for developing mathematical models, innovative design tools, and elements of information systems architecture;;

<b>Cipher</b>	<b>Competence</b>	<b>Indicators of competence achievement (within the discipline)</b>
	models of investigated objects and processes related to professional activity in the field of training and participate in their implementation in the form of software products.	PC-2.2 Can develop and implement algorithms for mathematical models based on modeling languages and application packages;; PC-2.3 Has practical experience in developing options for implementing information systems using innovative toolkits;
PC-4	Able to conduct work and research on processing and analyzing scientific and technical information in the field of application of mathematical methods and information technologies for the creation of space products and provision of space services based on the use of remote sensing data and geoinformation systems	PC-4.1 Knows the fundamental principles of remote sensing, basic mathematical methods and information technologies in the application of Earth remote sensing systems. Knows the theory and methodology of creating thematic information products and providing services based on the use of remotely sensed data and geoinformation systems;; PC-4.2 Can solve analytical problems, knows how to use geographic information system software packages, understands the big data approach and basic data processing workflows, knows how to use remote sensing materials and geographic information technology in modeling and interpreting interpretation of interpretation results;; PC-4.3 Proficient in creating space products and providing space services using remote sensing data and geographic information systems;
PC-5	Able to analyze, including in English, techniques for investigating ballistic and dynamic characteristics in spacecraft flight trajectory modeling	PC-5.1 Knows established and applied techniques, including those from English-language sources, for investigating ballistic and dynamic performance in spacecraft flight path modeling;; PC-5.2 Know how to develop and modernize techniques for investigating ballistic and dynamic characteristics in spacecraft flight trajectory modeling;; PC-5.3 Possesses methods and approaches to investigate ballistic and dynamic characteristics in spacecraft flight trajectory modeling;

### 3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF OPVO

The discipline "Modern methods of remote sensing and geoinformation systems" belongs to the compulsory part of the block 1 "Disciplines (modules)" of the educational program of higher education.

Within the framework of the educational program of higher education students also master other disciplines and/or practices that contribute to the achievement of the planned results of mastering the discipline "Modern remote sensing methods and geoinformation systems".

*Table 3.1. List of the components of the EP HEI, contributing to the achievement of the planned results of mastering the discipline*

<b>Cipher</b>	<b>Name of competence</b>	<b>Previous disciplines/modules, practices*</b>	<b>Subsequent disciplines/modules, practices*</b>
GC-7	Able to search for necessary sources of information and data, to perceive, analyze, remember and transfer information using digital means, as well as with the help of algorithms when working with data received from various sources in order to effectively use the obtained information to	Programming; <i>Machine Learning and Big Data Mining**</i> ; <i>From Data Acquisition to Data Treatment**</i> ; <i>Virtual Reality and Computer Vision**</i> ; <i>Modelling and Validation**</i> ;	Pre-Graduation Internship in Industry; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training;

Cipher	Name of competence	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
	solve problems; to evaluate information, its reliability, to build logical inferences on the basis of incoming information and data		
GC-1	Able to critically analyze problem situations on the basis of a systematic approach, develop a strategy of action	<i>Machine Learning and Big Data Mining**;</i> <i>From Data Acquisition to Data Treatment**;</i> Cross-Cultural Training; Programming; Databases;	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / NIR; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training; Pre-Graduation Internship in Industry; System Design; Dynamics and Control of Space Systems;
PC-1	Able to formulate goals, objectives of scientific research in the field of applied mathematics and computer science, computer science and modern programming technologies, select methods and means of problem solving	<i>From Data Acquisition to Data Treatment**;</i> <i>Applied Mechanics and Engineering**;</i> <i>Systems Engineering**;</i> <i>Virtual Reality and Computer Vision**;</i> <i>Modelling and Validation**;</i> Programming; Databases; <i>Machine Learning and Big Data Mining**;</i>	Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / NIR; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training; System Design; Dynamics and Control of Space Systems;
PC-2	Able to apply modern theoretical and experimental methods of development of mathematical models of investigated objects and processes related to professional activity in the field of training and participate in their implementation in the form of software products.	Programming; Databases; <i>Machine Learning and Big Data Mining**;</i> <i>From Data Acquisition to Data Treatment**;</i> <i>Virtual Reality and Computer Vision**;</i> <i>Modelling and Validation**;</i>	System Design; Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / NIR; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training;
PC-4	Able to conduct work and research on processing and analyzing scientific and		Pre-Graduation Internship in Industry;

Cipher	Name of competence	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
	technical information in the field of application of mathematical methods and information technologies for the creation of space products and provision of space services based on the use of remote sensing data and geoinformation systems		Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / NIR; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training;
PC-5	Able to analyze, including in English, techniques for studying ballistic and dynamic characteristics in spacecraft flight trajectory modeling	<i>English Language;</i> <i>Applied Mechanics and Engineering**;</i> <i>Systems Engineering**;</i> <i>Russian as a Foreign Language;</i>	Pre-Graduation Internship in Industry; Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / NIR; Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center); Technological Training; System Design; On-board Energy; Dynamics and Control of Space Systems;

\* - to be filled out in accordance with the competence matrix and the IPS of the Program of study

\*\* - elective disciplines/practices

#### 4. SCOPE OF THE DISCIPLINE AND TYPES OF ACADEMIC WORK

The total labor intensity of the discipline "Advanced Methods of Remote Sensing and Geoinformation Systems" is "10" credit units.

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

Type of training work	TOTAL, ac.h.		Semester(s)
			2
<i>Contact work, ac.h.</i>	144		144
Lectures (LK)	72		72
Laboratory work (LW)	72		72
Practical/seminar classes (SP)	0		0
<i>Independent work of students, ac.h.</i>	180		180
<i>Control (exam/assessed credit), ac.h.</i>	36		36
<b>Total labor intensity of the discipline</b>	<b>ac.h.</b>	<b>360</b>	<b>360</b>
	<b>credit.</b>	<b>10</b>	<b>10</b>

## 5. DISCIPLINE CONTENT

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

Section number	Name of the discipline section	Content of the section (topic)		Type of training work*
Section 1	Introduction	1.1	Definition and overview of history, evolution, remote sensing systems	LK, LR
		1.2	Electromagnetic radiation (EMR), terms and definitions, radiation laws, EM spectrum, sources of EMR.	LK, LR
Section 2	Remote sensing systems	2.1	Active and passive systems, mapping and other systems, notion of resolution in remote sensing - spatial, spectral, radiometric and temporal	LK, LR
		2.2	Earth observation orbits and platforms.	LK, LR
Section 3	Applications	3.1	Applications of remote sensing to earth, ocean, atmospheric, disaster and climate change sciences	LK, LR
Section 4	Geoinformatics fundamentals	4.1	Geographic Information System: overview, software and data, spatial and attribute data, vector and raster data, layers, networks and web clients	LK, LR
		4.2	Open and Commercial GIS. Thematic GIS applications	LK, LR
Section 5	Geographic information systems and spatial data	5.1	Data sources for GIS. Data input issues.	LK, LR
		5.2	Remote sensing as a data source. Geo-referencing and map projections in GIS.	LK, LR
Section 6	Thematic mapping, surfaces and digital elevation model (DEM)	6.1	Compiling thematic maps, types of digital elevation models, algorithms for working with DEM, creating 3D terrain models	LK, LR
Section 7	Analytical GIS functions	7.1	Typical requests	LK, LR
		7.2	Overlay. Spatial queries in GIS	LK, LR

\* - to be filled in only for **full-time** education: LK - lectures; LL - laboratory work; SL - practical/seminar classes.

## 6. MATERIAL AND TECHNICAL SUPPORT OF THE DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Classroom equipment	Specialized training/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	Auditorium for lecture-type classes, equipped with a set of specialized furniture; blackboard (screen) and technical means of multimedia presentations.	
Computer lab	Computer class for classes, group and individual consultations, current control and interim certification, equipped with personal computers (15 pcs.), blackboard (screen) and technical means of multimedia presentations.	
For independent work	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 the EIOS.	

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

## 7. EDUCATIONAL-METHODICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

### *Primary Literature:*

1. Star, J. a Burroughs, P.P. & McDonnel, R.A. 1998, Principles of GIS, Oxford University Press, pp. 299.
2. Chrisman, N. R. (1997) Exploring Geographic Information Systems. John Wiley and Sons
3. deMers, M.N.. (1997) Fundamentals of Geographic Information Systems. John Wiley and Sons.
4. Maguire, D.J., Goodchild, M.F. and Rhind, D.W.. (eds.) (1991) Geographic Information Systems: Principles and Applications. Avon, Longman Scientific and Technical
5. Martin, D. (1991) Geographical Information Systems and their Socioeconomic Applications. London, Routledge
6. Burroughs, P.P. & McDonnel, R.A. (1998) Principles of GIS, Oxford University Press, pp. 162 -166

### *Supplementary Literature:*

1. Lillesand Thomas M. & Kiefer Ralph: Remote Sensing and Image Interpretation Third Edition John Wiley
2. Subudhi, A.P., Sokhi, B.S., Roy P.S. (2001). Remote Sensing and GIS Applications in Urban and Regional Studies. Human Settlement Analysis Group, Indian Institute of Remote Sensing, Dehradun

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

1. RUDN EBS and third-party EBS, to which the university students have access on the basis of concluded agreements
  - PFUR Electronic Library System - PFUR EBS <http://lib.rudn.ru/MegaPro/Web>
  - EBS "University Library Online" <http://www.biblioclub.ru>
  - EBS Yurait <http://www.biblio-online.ru>
  - EBS "Student Consultant" [www.studentlibrary.ru](http://www.studentlibrary.ru)
  - Trinity Bridge EBS
2. databases and search engines
  - electronic fund of legal and normative-technical documentation <http://docs.cntd.ru/>
  - Yandex search engine <https://www.yandex.ru/>
  - Google search engine <https://www.google.ru/>
  - SCOPUS abstract database <http://www.elsevierscience.ru/products/scopus/>

### *Educational and methodical materials for independent work of students in mastering the discipline/module\*:*

1. Course of lectures on the discipline "Modern methods of remote sensing and geoinformation systems".

\* - all educational and methodical materials for independent work of students are placed in accordance with the current order on the page of the discipline **in TUIS!**

## 8. EVALUATION MATERIALS AND SCORING AND RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCIES IN THE DISCIPLINE

Evaluation materials and point-rating system\* for assessing the level of competences (part of competences) formed by the results of mastering the discipline "Modern remote sensing methods and geoinformation systems" are presented in the Appendix to this Working Program of the discipline.



\* - OM and BRS are formed on the basis of the requirements of the relevant RUDN local normative act.

**DEVELOPER:**

Associate Professor

*Position, BUP*

*Caption*

Dryga Danil Olegovich

*Last Name First Name.*

**HEAD OF BUP:**

Head of Department

*BUP position*

*Caption*

Razumny Yuri

Nikolayevich

*Last Name First Name.*

**HEAD OF OPS WO:**

Professor

*Position, BUP*

*Caption*

Razumny Yuri

Nikolayevich

*Last Name First Name.*