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

GEOINFORMATION SYSTEMS AND APPLICATIONS
(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 "Geoinformation Systems and Applications" 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 third semester of the second year. The course is offered by the Department of Mechanics and Control Processes. It consists of two sections and seven topics and focuses on the principles of GIS operation, spatial analysis methods (vector, raster, network), geodatabase creation and management technologies, and practical application of GIS in applied fields.

The purpose of mastering this course is to develop students' systematic theoretical knowledge and practical competencies in the field of geographic information systems, spatial analysis methods, and geodata processing technologies necessary for solving applied professional problems in various sectors of the economy and territorial management.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Geoinformation systems and their application" 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-1	Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics	GPC-1.1 Knows the basic laws, provisions and methods in the field of natural sciences and mathematics; GPC-1.2 Able to identify the natural scientific essence of control problems in technical systems guided by the laws and methods of natural sciences and mathematics; GPC-1.3 Proficient in tools for analyzing control problems in technical systems;
GPC-9	Capable of developing methods and performing experiments at existing facilities with processing of results based on information technology 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 conduct experiments at existing facilities with processing of results using information technology;

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

Course "Geoinformation systems and their application" 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 "Geoinformation systems and their application."

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-1	Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics	Mathematics for Spatial Sciences; Applied Statistics; Introduction to Geospatial Technology;	Undergraduate practice / Pregraduation practice;
GPC-9	Capable of developing methods and performing experiments at existing facilities with processing of results based on information technology and technical means	Introduction to Geospatial Technology; Advance Python Programming for Spatial Analytics; Operations Research and Optimization Techniques;	Undergraduate practice / Pregraduation practice;

* - 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 discipline “Geoinformation systems and their application” 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)**
			3
Contact work, academic hours	*34*		*34*
Lectures (LC)	17		17
Laboratory work (LW)	17		17
Practical/seminar classes (SC)	0		0
Independent work of students, academic hours	*38*		*38*
Control (exam/test with assessment), academic hours	*36*		*36*
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 types of academic work

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
Section 1	Theoretical foundations and technologies of geographic information systems	1.1	Introduction to GIS: Basic Concepts and Structure	Definition of GIS and its development history. Classification of GIS (by territorial coverage, functionality, and problem-oriented approach). GIS components: hardware, software, data, methods, and specialists. Areas of GIS application (ecology, urban planning, transportation, agriculture, oil and gas, and the Ministry of Emergency Situations).	LC, LW
		1.2	Spatial data and data models	Understanding spatial and attribute data. Methods of organizing spatial data: raster model (pixel, resolution, zones) and vector model (point, line, polygon). Their advantages and disadvantages. Topological data models. Geodata storage formats (Shapefile, GeoPackage, File Geodatabase, raster formats).	LC, LW
		1.3	Coordinate systems and map projections	The concept of a geodetic datum. Geographic coordinate systems (latitude/longitude) and rectangular (projected) coordinates. Cartographic projections: classification by the nature of distortion (conformal, equal-area, arbitrary). Coordinate systems used in the Russian Federation: SC-90, WGS-84, MSK (local coordinate systems). Data reprojection.	LC, LW
		1.4	Spatial Analysis: Basic Operations	Understanding spatial queries. Selecting objects by attributes and by location (Select by Attributes, Select by Location). Spatial joins (Spatial Join). Vector analysis: buffering, overlay (Intersect, Union, Erase, Clip). Raster analysis: reclassification, map algebra, raster calculator.	LC, LW
Section 2	Applied application of GIS and solving industry problems	2.1	Digital terrain modeling and 3D analysis	Terrain data sources: SRTM, ASTER GDEM, ALOS PALSAR, lidar data. Digital elevation model (DEM) and digital terrain model (DTM) generation. Derived morphometric map creation: slope, aspect, horizontal and vertical curvature. Hydrological modeling: drainage basin identification, thalweg construction. 3D scene and profile generation.	LC, LW
		2.2	GIS in ecology and nature management	Assessment of anthropogenic impact on the territory. Monitoring vegetation condition using vegetation indices (NDVI, SAVI). Mapping of disturbed lands. Analysis of pollution spread (modeling of buffer zones for industrial facilities). Ecological zoning of the territory. Maintenance of cadastres of specially protected nat-	LC, LW

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
				ural areas (SPNA).	
		2.3	Design and presentation of GIS analysis results. Map creation	Cartographic design principles. Map layout creation: adding layers, scale bar, legend, north arrow, and output data (title, date, source). Map export to raster and vector formats (JPG, PNG, PDF, SVG). Creating interactive web maps (QGIS). Preparing analytical reports with cartographic data.	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.	Computer class
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.	Computer class

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

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Zolnikov, I. D. Introduction to geoinformation systems and remote sensing: a textbook for universities / I. D. Zolnikov, N. V. Glushkova. - Moscow: Yurait Publishing House, 2025. - 118 p. - (Higher education). - ISBN 978-5-534-18577-5.

2. Berdenov, Zh. G. Application of geographic information systems in modern geographical science: a tutorial. - Almaty: ESPI, 2023. - 264 p. - ISBN 978-601-327-887-2.

3. Tolstov, E. G. GIS in cadastral activities: a tutorial / E. G. Tolstov, N. V. Kanashin, O. M. Mater, V. E. Bozhbov. - St. Petersburg: SPbGLTU, 2023. - 136 p.

Further reading:

1. Kurakina, N. I. Organization and geoanalysis of digital data: a tutorial / N. I. Kurakina, N. V. Orlova. - St. Petersburg: Publishing house of ETU "LETI", 2024. - 53 p. - ISBN 978-5-7629-3418-3.

2. Karimi, H. A. Big Data: Techniques and Technologies in Geoinformatics / edited by H. A. Karimi. — 2nd ed. - CRC Press, 2025. - 385 p. — ISBN 9781032919539.

3. de Lange, N. Geoinformatics in Theory and Practice: An Integrated Approach to Geoinformation Systems, Remote Sensing and Digital Image Processing. — Springer, 2025.

4. Remote Sensing, GIS and GPS: Principles and Applications. - Zenodo, 2025. - 15.9 MB.

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 "Geoinformation systems and their application".

* - 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:

Senior Lecturer		Shemyakina Elizaveta Mikhailovna
Position, DEPARTMENT	*Signature*	*Surname I.O.*

HEAD OF THE DEPART-MENT:

Head of Department		Razumny Yuri Nikolaevich
Position of the DEPARTMENT	*Signature*	*Surname I.O.*

HEAD OF THE EP HE:

Professor		Razumny Yuri Nikolaevich
Position, DEPARTMENT	*Signature*	*Surname I.O.*