

**БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ /
BELARUSIAN STATE UNIVERSITY**

УТВЕРЖДАЮ / APPROVED

Ректор Белорусского
государственного университета/
Rector of Belarusian State University

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Регистрационный/Registration № 3490/m.

**ФУНКЦИОНАЛЬНЫЙ АНАЛИЗ ПРОГРАММНОГО ГИС-
ОБЕСПЕЧЕНИЯ /**

GIS SOFTWARE FUNCTIONALITY

Учебная программа учреждения образования по учебной дисциплине для
специальности:

The program of the educational institution of the discipline for the speciality:

7-06-0532-03 Землеустройство, кадастры, геодезия и геоматика /

7-06-0532-03 Land Management, Cadastres, Geodesy and Geomatics

Профилизация: Управление геоданными с использованием интеллектуальных
систем / Profilization: Geodata management using intelligent systems

Учебная программа составлена на основе ОСВО 7-06-0532-03-2023; учебного плана БГУ № М47а-5.7-06/уч. от 02.05.2025

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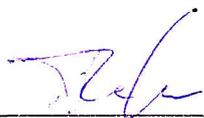
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РЕКОМЕНДОВАНА К УТВЕРЖДЕНИЮ:

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(протокол № 12 от 18.06.2025);

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ПОЯСНИТЕЛЬНАЯ ЗАПИСКА

Цели и задачи учебной дисциплины

Цель учебной дисциплины – формирование знаний теоретических основ, умений и навыков в области геоинформационного программного обеспечения.

Задачи учебной дисциплины:

1. освоение базового понятийно-терминологического аппарата и нормативно-правовой базы геоинформатики и ГИС;
2. овладение методологией и методикой ГИС-анализа, ГИС-картографирования;
3. изучение принципов формирования и управления базами географической информации;
4. освоение особенностей выполнения математико-статистической обработки геоданных;
5. формирование навыков выполнения типовых операций с пространственной информацией в геоинформационной среде.

Место учебной дисциплины в системе подготовки специалиста с углубленным высшим образованием.

Учебная дисциплина относится к модулю «Геоинформационный анализ геоданных» компонента учреждения образования.

Учебная дисциплина составлена с учетом межпредметных связей с учебной дисциплиной «Информационные технологии в профессиональной деятельности» государственного компонента.

Требования к компетенциям

Освоение учебной дисциплины «Функциональный анализ программного ГИС-обеспечения» должно обеспечить формирование следующей специализированной компетенции:

использовать методы автоматизированного анализа пространственных данных в современных геоинформационных программных приложениях.

В результате освоения учебной дисциплины обучающийся должен:

знать: устройство компьютерной системы; назначение периферийных устройств; аппаратно-программный комплекс геоинформационных программ и приложений; базовые понятия и методы анализа пространственных данных; основные модели представления пространственных данных; функциональные возможности программного обеспечения геоинформационных систем;

уметь: выполнять первичный анализ геоданных; создавать базы данных пространственной информации и управлять ими; выполнять математико-статистическую обработку геоданных; оперировать основными моделями представления пространственных данных в геоинформационной среде;

иметь навык: геоинформационными методами обработки пространственных данных с помощью компьютерных систем.

Структура учебной дисциплины

Дисциплина изучается в 1 семестре. В соответствии с учебным планом всего на изучение учебной дисциплины «Функциональный анализ программного ГИС-обеспечения» отведено:

- для очной формы получения углубленного высшего образования – 96 часов, в том числе 56 аудиторных часов, из них: лекции – 16 часов, практические занятия – 40 часов. Из них:

лекции – 12 часов, практические занятия – 34 часа, внеаудиторная управляемая самостоятельная работа (УСР) – 10 часов.

Трудоемкость учебной дисциплины составляет 3 зачетные единицы.

Форма промежуточной аттестации – зачет.

EXPLANATORY NOTE

Aim and tasks of the discipline – to form knowledge of the theoretical foundations, skills, and competencies in the field of geographic information software.

Tasks of the discipline:

1. Mastering the basic conceptual and terminological framework and the regulatory-legal basis of geoinformatics and GIS.
2. Acquiring the methodology and techniques of GIS analysis and GIS mapping.
3. Studying the principles of forming and managing geographic information databases.
4. Mastering the specifics of performing mathematical-statistical processing of geodata.
5. Developing skills in performing standard operations with spatial information in a geoinformation environment.

Place of the academic discipline in the system of training a specialist with advanced higher education.

The academic discipline is part of the module «Geoinformation analysis of geodata» of educational institution component.

The academic discipline «GIS software functionality» refers to the module «Information technologies in professional activities» of the state component.

Requirements for competences

Mastering of the academic discipline «GIS software functionality» should provide the formation of the following special competences:

SC. To use techniques for automated analysis of spatial data in modern geoinformation software application.

As a result of mastering the academic discipline, the student is expected to:

know: the structure of a computer system; the purpose of peripheral devices; the hardware-software complex of geoinformation programs and applications; basic concepts and methods of spatial data analysis; main models of spatial data representation; functional capabilities of geographic information system software.;

be able to: perform primary analysis of geodata; create and manage spatial information databases; perform mathematical-statistical processing of geodata; operate with the main models of spatial data representation in a geoinformation environment.

have skills in: processing spatial data using geoinformation methods with computer systems.

Structure of the academic discipline

The discipline is studied in the 1 semester. In total for the study of the discipline «GIS software functionality» is allocated for full-time form of obtaining advanced higher education – 96 hours, including 56 in-class hours, of them: lectures – 16 hours, practical work – 40 hours, of them:

lectures – 12 hours, practical work – 34 hours, extracurricular controlled self-study (CSS) – 10 hours.

The labour intensity of the academic discipline is 3 credit units.

The form of certification is an end-of-term test.

CONTENT OF THE STUDY MATERIAL

Topic 1. Introduction to GIS

Basic concepts of geoinformatics, geographic information systems (GIS), geoinformation mapping. The history of the creation and evolution of geoinformation software. System software and application software. A set of GIS functionalities and specialized software tools. The market of software for GIS-mapping of lands (instrumental GIS, GIS-viewers, software for preprocessing and decoding of Earth remote sensing data, vectorization programs, software for processing field geodetic observations). Cartography and Land Management Standards. Spatial data infrastructure. Legal support for mapping, land management and cadastres in the Republic of Belarus.

Topic 2. Classifications and review of software

Instrumental GIS, GIS-viewers, remote sensing data processing tools, vectorizers of raster cartographic images, spatial modeling tools, reference cartographic systems. The main developers of GIS software.

Geographic information technologies and functional groups: format conversion, digitalization, vectorization, creation and processing of digital terrain models, interaction with satellite positioning systems, etc.

Topic 3. Data sources for GIS

Sources of data for GIS. Data, information, knowledge in geoinformatics. Spatial and attributive data in GIS. Data formats for GIS.

OGC. GIS data licensing. Legal features of the collection, creation, distribution and use of spatial data.

Geographic Maps. Geodetic measurements. Basic geodetic and measuring instruments used in ground instrumental survey. Ground survey materials. Accuracy, detail and completeness of plans and maps.

Satellite positioning systems. Global positioning systems GPS, GLONASS, Galileo, BeiDou.

Remote sensing data. The concept of photographic, photo-television, scanner, thermal, infrared, radiometric, radar surveys. Characteristics of the main satellite imagery systems (Landsat (7, 8, 9), Sentinel (1, 2), PlanetScope).

Geoportals. GeoServer. GeoNode. OGC Web Services. WFS. WMS. WMTS.

Open data. Natural Earth. OpenStreetMap. Volunteered Geographic Information (VGI).

Geodata in Belarus. Geoportal of the land information system of the Republic of Belarus. Public cadastral map of the National Cadastral Agency. State Cartographic and Geodetic Fund of the Republic of Belarus. Belarusian space system for Earth remote sensing.

Statistical information. State cadastres and sectoral databases. The concept of state cadastres. State land, forest, water, town planning cadastres. State cadastre of atmospheric

air, specially protected natural areas, waste, mineral resources, flora and fauna. Unified state register of real estate, rights to it and transactions with it, register of land resources of the Republic of Belarus. Information database of land resources of agricultural organizations. Information base on the agrochemical properties of lands.

Topic 4. ESRI ArcGIS software

Software developers ArcGIS Desktop, ArcGIS Pro. Features of collection, storage, analysis and graphical visualization of spatial data. Functionality of the software. Visualization and features of the organization and presentation of spatial geoinformation. Toolkits for maintaining and analyzing geodatabases. Tools for creating and editing digital maps and models. Readable file formats. Processing and spatial analysis of GIS information. Means for the preparation of graphic information in digital and printed form, the formation of reporting documents.

Topic 5. QGIS and Open-Source GIS software

Open-Source GIS software. SAGA, GRASS, QGIS, GDAL. QGIS software developers. Features of collection, storage, analysis and graphical visualization of spatial data. Functionality of the software. Visualization and features of the organization and presentation of spatial geoinformation. Toolkits for maintaining and analyzing geodatabases. Tools for creating and editing digital maps and models. Readable file formats. Processing and spatial analysis of GIS information. Means for the preparation of graphic information in digital and printed form, the formation of reporting documents.

TEACHING AND METHODOLOGICAL MAP OF THE DISCIPLINE

Full-time form of higher education with the use of distance learning technologies (DLT)

Title of section, topic	Title of section, topic	In-class hours					Independent work	Form of control
		Lectures	Practical classes	Seminar classes	Laboratory classes	Other		
1	2	3	4	5	6	7	8	9
1.	Introduction to GIS	4						Electronic test
2.	Classifications and review of software	2						Electronic test
3.	Data sources for GIS	4	4				2	Electronic test. Practical report.
4.	ESRI ArcGIS software	1	10				4	Electronic test. Practical report.
5.	QGIS and Open-Source GIS software	1	20				4	Electronic test. Practical report.

INFORMATION AND METHODOLOGICAL PART

List of basic literature

1. Курлович, Д. М. ГИС в управлении земельными ресурсами = GIS for Land Resource Management : учебно-методическое пособие / Д. М. Курлович ; БГУ. - Минск : БГУ, 2024. - 190 p. - URL: <https://elib.bsu.by/handle/123456789/325904>

List of additional literature

1. The Routledge handbook of mapping and cartography / ed. by A. Kent, P. Vujakovic, Routledge (Firm). – Milton Park, Abingdon, Oxon ; New York, NY : Routledge, 2018. – 619 p.
2. Evaluating Participatory Mapping Software / ed. by C. M. Burnett. – Cham : Springer International Publishing, 2023. – 280 p.
3. Miles, S. QGIS for Ecologists: An Introduction to Mapping for Ecological Surveys. QGIS for Ecologists / S. Miles. – Pelagic Publishing Ltd., 2024. – 176 p.
4. Holloway, P. Understanding GIS through Sustainable Development Goals: Case Studies with QGIS. Understanding GIS through Sustainable Development Goals / P. Holloway. – 1th ed. – Boca Raton : CRC Press, 2023. – 339 p.
5. Huizinga, A. QGIS for Land Surveyors and Civil Designers / A. Huizinga. – Independently published, 2022. – 243 p.
6. Land Use Cover Datasets and Validation Tools: Validation Practices with QGIS. Land Use Cover Datasets and Validation Tools / ed. by D. García-Álvarez [et al.]. – Cham : Springer International Publishing, 2022. – 464 p.
7. Menke, K. Discover QGIS 3. x: A Workbook for Classroom or Independent Study. Discover QGIS 3. x / K. Menke. – Locate Press, 2019. – 406 p.
7. Graser, A. QGIS map design / A. Graser, G. N. Peterson. – Chugiak, AK, USA : Locate Press LLC, 2018. – 210 p.
8. QGIS and Applications in Water and Risks / ed. by N. Baghdadi, C. Mallet, M. Zribi. – Hoboken, NJ, USA : John Wiley & Sons, Inc., 2018. – 300 p.

List of recommended diagnostic tools and methodology for final mark formation

The object of diagnostics of master's degree students' competencies is knowledge and skills obtained by them as a result of studying the academic discipline. Identification of master's degree students' academic achievements is carried out using current monitoring and midterm assessment activities.

For current monitoring of the quality of knowledge acquisition by students, it is recommended to use the following diagnostic forms: practical report, electronic tests.

Assessment for answers in laboratory classes presupposes mastery of the educational material, skills in geodata postprocessing, skills in work with GIS software, the ability to argue one's own point of view.

The form of interim certification in the discipline «GIS software functionality» is provided for by the curriculum as end-of-term test.

Approximate list of assignments for controlled self-study

Topic 3. Data sources for GIS

Assignment 1. The components of spatial data infrastructure.

Form of control – test.

Topic 4. ESRI ArcGIS software

Assignment 1. ESRI Geodatabase: basic concepts. Feature Classes. Feature Datasets. Tables. Raster Datasets. Relationship Classes.

Form of control – test.

Topic 4. ESRI ArcGIS software

Assignment 2. ESRI ArcGIS Online. ArcGIS StoryMaps.

Form of control – test.

Topic 5. QGIS and Open-Source GIS software

Assignment 1. Open source geodata. OpenStreetMap: basic concepts. Nodes, ways, relations, tags.

Form of control – test.

Topic 5. QGIS and Open-Source GIS software

Assignment 2. QGIS, GRASS, SAGA compare.

Form of control – test

Approximate list of practical classes

Practical class 1. Introduction to GIS Software Interface and Data Import

Practical class 2. Creating and Editing Vector Data in ESRI ArcGIS

Practical class 3. Geodata Visualization and Symbolization in ESRI ArcGIS

Practical class 4. Spatial Data Analysis: Buffer and Overlay Operations

Practical class 5. Working with Attribute Data and Queries

Practical class 6. Raster Data Processing and Analysis

Practical class 7. Geodatabase Creation and Management in QGIS

Practical class 8. Spatial Data from OpenStreetMap (OSM) in QGIS

Practical class 9. Georeferencing and Digitizing Maps in QGIS

Practical class 10. Spatial Interpolation and Surface Analysis in QGIS

Practical class 11. Network Analysis in ESRI ArcGIS

Practical class 12. Topology Rules and Data Validation in ESRI ArcGIS

Practical class 13. Creating Web Maps in QGIS

Practical class 14. Automating GIS Workflows with Scripting

Description of innovative approaches and methods for teaching the discipline

The educational process in the academic discipline «GIS software functionality» is built using a **practice-oriented approach**, which involves:

1. mastering the content of education through solving practical problems;
2. acquisition of skills for the effective performance of various types of professional activities, including geoinformation analysis and modeling in solving scientific problems;
3. focus on generating ideas, implementing group projects, developing an entrepreneurial culture;
4. the use of procedures, methods of assessment, fixing the formation of professional competencies.

Methodological recommendations for the organization of independent work

Independent work of undergraduates in the academic discipline «GIS software functionality» involves an in-depth study of basic and additional literature, and practical work. For the organization of independent work of master's students in the academic discipline, it is planned to use modern information technologies, place in the network access a set of educational and educational materials (educational and program materials, educational publications for the theoretical study of the discipline, methodological instructions for practical classes, materials of current control and intermediate certification (questions for preparing for the end-of-term test, tasks, tests), a list of recommended literature, information resources, etc.

Approximate list of questions for the end-of-term test

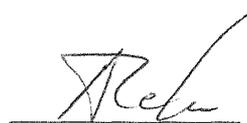
1. Define geoinformatics, geographic information systems (GIS), and geoinformation mapping.
2. Outline the history and evolution of GIS software.
3. Identify the main types of GIS software.
4. Explain the concept of spatial data infrastructure and its significance in GIS.
5. Classify GIS software into functional groups.
6. Compare the functionalities of instrumental GIS and GIS-viewers.
7. Differentiate between spatial and attributive data in GIS applications.
8. List common GIS data formats and their uses.
9. Explain the role of Open Geospatial Consortium (OGC) standards in ensuring GIS data interoperability.
10. Describe the characteristics of global positioning systems (GPS, GLONASS, Galileo, BeiDou).

11. Explain the concept of Volunteered Geographic Information (VGI) and its role in GIS data collection.
12. Define the types of remote sensing surveys.
13. Compare the characteristics of major satellite imagery system.
14. Describe OGC web services (WFS, WMS, WMTS) and their applications in GIS.
15. Describe the key features of ArcGIS Desktop and ArcGIS Pro for spatial data collection, storage, and analysis.
16. Describe the functionality of QGIS for spatial data visualization, geodatabase management, and analysis.
17. Describe the functionality of ArcGIS for spatial data visualization, geodatabase management, and analysis.

ПРОТОКОЛ СОГЛАСОВАНИЯ УЧЕБНОЙ ПРОГРАММЫ УО

Название учебной дисциплины, с которой требуется согласование	Название кафедры	Предложения об изменениях в содержании учебной программы учреждения высшего образования по учебной дисциплине	Решение, принятое кафедрой, разработавшей учебную программу (с указанием даты и номера протокола)
Учебная дисциплина не требует согласования			

Заведующий кафедрой почвоведения и геоинформационных систем,
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А.Н.Червань

18.06.2025

**ДОПОЛНЕНИЯ И ИЗМЕНЕНИЯ К УЧЕБНОЙ ПРОГРАММЕ ПО
ИЗУЧАЕМОЙ УЧЕБНОЙ ДИСЦИПЛИНЕ**

на ____ / ____ учебный год

№ п/п	Дополнения и изменения	Основание

Учебная программа пересмотрена и одобрена на заседании кафедры почвоведения и геоинформационных систем (протокол № ____ от _____ 202_ г.)

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