

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE
Department of Geoinformatics and Aerospace Research of the Earth

APPROVED

Faculty of Land Management

May 14, 2026

CURRICULUM OF ACADEMIC DISCIPLINE

« MATHEMATICAL STATISTICS FOR GEODATA »

Area of knowledge G "Engineering, Manufacturing and Construction"

Specialty G18 Geodesy and land management

Academic programme "Geodesy and Land Management"

Faculty Land Management

Developed by: Senior Lecture, Candidate of Economic Sciences Bohdanna ZAIACHKIVSKA

(position, academic degree, academic title)

Description of the academic discipline

The task of studying the discipline is to form in the specialist theoretical knowledge and practical skills of geostatistics, mathematical and statistical apparatus of methods of processing geospatial data and their properties. In particular, the tasks use spectral properties of spatial objects, derived products (vegetation indices, leaf surface area) with corresponding cartographic projections, which require constant transformations and their further practical use on the basis of geoinformation technologies in GIS analysis of data and indicators regarding the state of land relations and land cadastral data.

Area of knowledge, specialty, academic programme, academic degree		
Academic degree	<i>Bachelor</i>	
Specialty	<i>G18 Geodesy and land management</i>	
Academic programme	<i>Geodesy and land management</i>	
Characteristics of the discipline		
Type	Main	
Total number of hours	90 hours.	
Number of ECTS credits	3	
Number of modules	2	
Course project (work) (if any)	None	
Form of assessment	Test	
Indicators of the discipline for full-time and part-time forms of university study		
	Full-time	Part-time
Year of study	2	2
Term	3	3- 4
Lectures	3 p.m.	4 hours.
Practical classes and seminars	-	-
Laboratory classes	30 hours.	-
Self-study	45 hours.	-
Number of hours per week for full-time students	3 hours.	

1. Aim, competences and expected learning outcomes of the discipline

The main aim of the discipline "Mathematical Statistics for Geodata" is to ensure that students master the fundamentals of using mathematical and statistical methods and applied processing of geodata and indicators of the state of land relations based on the use of modern computer technologies.

List of disciplines that precede the study of the discipline "Mathematical Statistics for Geodata":

"Higher Mathematics". Part 1, Part 2 – mathematical statistics is based on probability theory, integrals, and matrices, which are studied precisely in the higher mathematics course;

"Geoinformatics, Informatics, and Programming". Part 1 and Part 2 – provides knowledge on how to code algorithms (for example, for calculating the mean, variance, or standard deviation for thousands of points);

"Topography" and "Geodesy" – it is in these disciplines that students make measurements for the first time (angles, distances, elevations) and learn that any measurement has an error. Mathematical statistics is needed precisely to estimate and minimize these errors.

Competencies acquired:

- integral competences :

IC. Ability to solve complex specialized tasks geodesy and land management

- general competences:

GC01. Ability to learn and master modern knowledge; ZK02. Ability apply knowledge in practical situations; ZK07. Ability to work autonomously;

GC12. Ability to exercise one's rights and responsibilities as a member of society; awareness of the value of civil (free democratic) society and the need for its sustainable development, the rule of law, and the rights and freedoms of man and citizen in Ukraine;

GC13. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of history and the patterns of development of subject matter the area, its place in the general system of knowledge about nature and society, as well as in the development of society, techniques and technologies, use different types and forms motor activities for recreation and leading a healthy lifestyle.

- special competences:

SC01. Ability to apply fundamental knowledge to analyze phenomena of natural and man-made origin when performing professional tasks in the field of geodesy and land management;

SC02. Ability to apply theories, principles, and methods of physical and mathematical, natural, socio-economic, and engineering sciences when performing geodesy and land management tasks;

SC03. Ability to apply regulatory legal acts, regulatory and technical documents, reference materials in professional activities;

SC04. Ability to select and use effective methods, technologies and equipment for carrying out professional activities in the field of geodesy and land management;

SC05. Ability to apply modern information, technical and technological support to solve complex issues of geodesy and land management;

SC06. Ability to perform remote, ground, field and office research, engineering calculations for processing research results, formalize research results, prepare reports when solving geodesy and land management tasks;

SC07. Ability to collect, update, process, critically evaluate, interpret, store, publish and use geospatial data and metadata regarding objects of natural and man-made origin.

- expected learning outcomes (ELO):

ELO2. Organize and manage professional development persons and groups;

ELO3. Communicate information, ideas, problems, solutions, own experience and arguments to specialists and non-specialists;

ELO4. Know and apply in professional activities regulatory and legal acts, regulatory and technical documents, reference materials in the field of geodesy and land management and related industries;

ELO5. Apply conceptual knowledge of natural and socio-economic sciences when performing tasks in geodesy and land management;

ELO9. Collect, evaluate, interpret and use geospatial data, metadata about objects of natural and man-made origin, apply statistical methods of their analysis for solving specialized problems in the field of geodesy and land management.

2. Program and structure of the academic discipline

- complete term daytime (correspondence) forms obtaining higher education;
- abbreviated term daytime (correspondence) forms acquisition higher education.

Modules and topics	Number hours													
	full-time							part-time						
	weeks	total	including					total	including					
			l	p	lab	ind	s.st.		l	p	lab	ind	s.st.	
2	3	4	5	6	7	8	9	10	11	12	13	14		
1														
Content-based module 1. <i>Foundations theories probabilities and basic statistical indicators</i>														
Topic 1. Nature of geodata and tools for their analysis.	1	6	2		4				1					
Topic 2. Fundamentals of probability theory in geodesy and land management.	3	6	2		4				1					
Topic 3. Primary analysis and descriptive statistics.	5	6	2		4									
Together by meaningful module		18	6		12			2	2					
Content-based module 2. <i>Foundations statistical analysis land surveyors geodata</i>														
Topic 4. Statistical sampling and hypothesis testing.	7	14	2		2		10		1					
Topic 5. Spatial analysis and distribution patterns (Spatial Statistics).	9	16	2		4		10							
Topic 6. Correlation and regression analysis of geodata.	11	16	2		4		10							
Topic 7. Multivariate statistical analysis and clustering.	13	26	3		8		15		1					
Together by meaningful module		72	9		18		45	2	2					
Total hours		90	15		30		45	4	2					

3. Topics of lectures

No.	Topic	Hours
1	Topic 1. Nature of geodata and tools for their analysis.	2
2	Topic 2. Fundamentals of probability theory in geodesy and land management.	2
3	Topic 3. Primary analysis and descriptive statistics.	2
4	Topic 4. Statistical sampling and hypothesis testing.	2
5	Topic 5. Spatial analysis and distribution patterns (Spatial Statistics).	2

6	Topic 6. Correlation and regression analysis of geodata.	2
7	Topic 7. Multivariate statistical analysis and clustering.	3

4. Topic of laboratory (practical, seminars) classes

No.	Topic	Hours
1	Calculation of basic statistical indicators (Mean, Median, Variance) and construction of distribution histograms in MS Excel.	2
2	Express visualization of numerical arrays and evaluation of distribution shape using Data Info and Distributions widgets in Orange.	2
3	Search for logical input errors, "outliers" and cleaning of attribute tables using conditional formatting in MS Excel.	2
4	Visual comparison of land management indicator groups and analysis of anomalous values using Box Plot diagrams in Orange.	2
5	Calculation of linear Pearson correlation coefficients for land value and quality factors using tools of the "Data Analysis" package in MS Excel.	2
6	Spatial analysis of patterns and autocorrelation of geodata.	2
7	Construction of interactive relationship matrices and scatter plots (Scatter Plot) in Orange.	2
8	Construction of one-dimensional linear models and outputting trend equations on graphs in MS Excel.	2
9	Multiple linear regression in Orange: model accuracy assessment by coefficient of determination (R^2) and forecasting of indicators for new objects.	2
10	Visualization of spatial vector point layers and construction of heatmaps of phenomenon density (Kernel Density Estimation) in QGIS.	2
11	Mathematical calculation of the mean geographic center (Mean Center) and standard deviation radius with code in Google Colab.	2
12	Integration of geographical coordinates into attribute tables and formation of final spatial arrays in QGIS.	2
13	Writing automated data processing scripts (Data Science) and visualization of correlation matrices with scipy and seaborn libraries in Google Colab.	2
14	Automatic clustering of territorial communities by a complex of features using the K-Means machine learning algorithm in Orange.	2
15	Thematic mapping, data merge operations (Join) and final spatial zoning of territories in QGIS.	2

5. Topics of self-study

No.	Topic	Hours
1	Basic concept geostatistics in field land relations	9
2	Basic aspects using program Orange for carrying out statistical analysis	10
3	Using trees solutions for processing geodata	8
4	Program product QGIS for goals statistical analysis geospatial data	8
5	Mathematical and statistical methods processing geospatial data	10

6. Methods assessing expected learning outcomes:

- test;

- modular tests;
- protection laboratory work.

7. Teaching methods:

- verbal method (lecture, discussion, interview etc);
- practical method (laboratory, practical occupation);
- visual method (method illustrations, demonstration method);
- work with educational and methodological literature (note-taking, thesis, annotating, reviewing, writing an abstract);
- video method (remote, multimedia, web-based etc);
- independent work (implementation tasks).

8. Results assessment The knowledge of a higher education applicant is assessed on a 100-point scale and is converted into a national assessment in accordance with the current "Regulations on Examinations and Tests at the NUBiP of Ukraine"

8.1. Distribution of points by types of educational activities

Topic	Learning outcomes	Evaluation
First semester		
Module 1. INFORMATION TECHNOLOGIES IN GEODESY AND LAND MANAGEMENT		
Topic 1. Nature of geodata and tools for their analysis	GC01, GC02, SC05, SC07, PLO5, PLO9 Learning Outcomes: To know the differences between spatial and attribute geodata in land management; to understand the architecture and interfaces of analysis tools (QGIS, Orange, Google Colab); to be able to distinguish between qualitative and quantitative indicators of the state of land relations.	
Topic 2. Fundamentals of probability theory in geodesy and land management.	SC01, SC02, SC06, PLO5, PLO9 Learning Outcomes: To understand the concept of random variables and the nature of errors in geodesic measurements; to know distribution laws (specifically normal distribution); to be able to apply the rules of operations with probabilistic events to estimate the accuracy of office (computational) works.	
Topic 3. Primary analysis and descriptive statistics.	GC02, SC04, SC06, PLO9 Learning Outcomes: To be able to calculate basic statistical metrics (mean, median, mode, variance, range) for evaluating the normative monetary value and areas of land plots; to be able to construct and interpret variational series and data distribution histograms.	
Modular control		30
Together by content module 1		100
Module 2. PROCESSING OF LAND INFORMATION IN WORD PROCESSORS		
Topic 4. Statistical sampling and hypothesis testing	GC07, SC06, SC07, PLO3, PLO9 Learning Outcomes: To understand the principles of forming a representative sample of geodata; to be able to detect logical input errors and anomalous "outliers" in attribute tables; to master the methodology of statistical hypothesis testing (specifically Student's t-test) for comparing land indicators.	

Topic 5. Spatial analysis and distribution patterns (Spatial Statistics).	IC, SC05, SC06, SC07, PLO4, PLO9 Learning Outcomes: To know the methods of integrating geographical coordinates (X, Y) into statistical analysis; to be able to perform density and concentration analysis of phenomena on a map (Heatmap tools in QGIS); to learn how to calculate the mean geographic center and analyze spatial autocorrelation (Moran's I index).	15
Topic 6. Correlation and regression analysis of geodata.	GC02, SC02, SC04, PLO5, PLO9 Learning Outcomes: To be able to assess the strength and direction of the relationship between land quality and value factors using correlation coefficients; to learn how to build linear and multiple regression models; to be able to carry out statistical forecasting of indicators based on models.	
Topic 7. Multivariate statistical analysis and clustering.	IC, GC12, GC13, SC04, SC05, SC07, PLO2, PLO9 Learning Outcomes: To master machine learning algorithms (specifically K-Means) for multivariate data analysis; to be able to conduct statistical zoning of territorial communities based on a complex of features; to learn how to visualize clustering results on thematic maps in QGIS.	
Modular control		30
Together by content module 2		100
Only for 1 semester		70
Test		30

8.2. Higher education student knowledge assessment scale

Higher education applicant rating, points	Assessment according to the national system	
	exams	credits
90-100	perfectly	enrolled
74-89	good	
60-73	satisfactorily	
0-59	unsatisfactorily	not included

8.3. Evaluation Policy

Deadline and resubmission policy	Works that are submitted late without good reason, are evaluated on lower assessment. Reassembling modules is happening from permission lecturer by availability respected reasons (for example, sick leave).
Academic Integrity Policy	Writing off under time control works and exams are prohibited (including using mobile devices). Abstracts, presentations must have correct textual link on the literature used.
Visitation Policy	Attendance at classes is mandatory. For objective reasons (e.g. illness, international internship) studies may take place individually (in online form by by agreement from dean faculty).

9. Educational and methodological support:

- electronic educational course of the academic discipline (on the educational portal of the NUBiP of Ukraine eLearn - <https://elearn.nubip.edu.ua/course/view.php?id=1561> ;
- lecture notes and their presentations on the educational portal of the NUBiP of Ukraine eLearn - <https://elearn.nubip.edu.ua/course/view.php?id=1561> ;
- methodical instructions
 - ✓ Кошель А.О. Статистичні методи в землеустрої / Кошель А.О., Новиков О.І. – Київ,

10. Recommended sources of information

Main:

1. М.І. Жалдак, Н.М. Кузьміна, Г.О. Михалін Ж24 Теорія ймовірностей і математична статистика: Підручник для студентів фізико-математичних та інформатичних спеціальностей педагогічних університетів. Видання четверте, доповнене / М.І. Жалдак, Н.М. Кузьміна, Г.О. М
2. Зацерковний В. І., Демидов В. К., Цюпа І. В., Малік Т.М. Моделювання в ГІС – 2024. х
3. Плічко, А. М., Акбаш, К. С., & Луньова, М. В. (2024). *Математична статистика*: Д
4. Чепурна, О. Є., Черевко, Є. В., Лобода, Ю. Г., & Кухаренко, С. В. (2025). Застосування математичної статистики для аналізу великих даних в алгоритмах обробки інформації. *Вчені записки Таврійського національного університету імені В. І. Вернадського. Серія: Технічні науки*, д
5. Гончаренко, О. О., & Яценко, О. В. (2025). *Математична картографія: Методичні вказівки до виконання практичних робіт для студентів 2 курсу*. Київський національний університет імені Тараса Шевченка. <https://geo.knu.ua/wp-content/uploads/2025/03/matematychna->

Auxiliary:

1. Bandurka, O. I. (2023). *Metody i alhorytmy analizu heodanykh dlia rishennia zadachi otsinky antropohennoho vplyvu na dovkillia* [Qualification scientific work on the rights of manuscript, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"]. Electronic Archive of Scientific Publications of Igor Sikorsky KPI (ELA KPI). <https://ela.kpi.ua/items/d33a1fa4-942c-4e15->
2. Чередыко, Д. О. (рік). Роль математичних методів у геоінформаційній розвідці (GEOINT). *Міжнародна науково-практична конференція «Математика в сучасному технічному університеті»* (с. 150). ІСЗЗІ КПІ ім. Ігоря Сікорського. [HYPERLINK "https://www.google.com/search?q=https://ela.kpi.ua/server/api/core/bitstreams/37550aa8-b5d1-4986-ba20-eca0225599de/content"](https://www.google.com/search?q=https://ela.kpi.ua/server/api/core/bitstreams/37550aa8-b5d1-4986-ba20-eca0225599de/content) [HYPERLINK "https://www.google.com/search?q=https://doi.org/10.32782/2663-5941/2025.4.2/41"](https://www.google.com/search?q=https://doi.org/10.32782/2663-5941/2025.4.2/41) <https://ela.kpi.ua/server/api/core/bitstreams/37550aa8-b5d1->
3. Шушпанов, Д. Г., Кожухар, Н. М., & Горовий, О. В. (2024). Аналіз статистичних даних у географії: інструменти та застосування для соціально-економічних та екологічних досліджень. В *Modern statistics: problems and perspectives of development*. Національна академія статистики, обліку

Informational resource:

1. Державна служба статистики України. URL: www.ukrstat.gov.ua
2. Державна служба України з питань геодезії, картографії та кадастру. URL: <http://land.gov.ua/>
3. Eurostat. URL: <https://ec.europa.eu/eurostat>
4. G
5. Biolab. (2026). *Orange Data Mining* [Комп'ютерна програма]. [HYPERLINK "https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content"](https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content) [HYPERLINK "https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content"](https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content) [HYPERLINK "https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content"](https://irb.nasoa.edu.ua/server/api/core/bitstreams/efd96abf-e242-40c8-bcea-11ea97e1e47e/content)
6. QGIS Project. (2026). *QGIS* [Комп'ютерна програма]. <https://qgis.org/download/>.