NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Geoinformatics and Aerospace Research of the Earth

"**CONFIRMED**"
Dean of the Faculty of Land management _____
T.O. Ievsiukov
«18» May 2023

"**APPROVED**"
at the meeting of the department of Geoinformatics and
Aerospace Research of the Earth
Protocol № 11 from 14 April 2023
A.i. head of Department
_____ O. P. Drozdivskyi

"**REVIEWED** "
Program Coordinator
_____ I.P. Kovalchuk.

PROGRAM OF THE COURSE

GEOINFORMATION SYSTEMS AND DATABASES

Specialization	193. Geodesy and Land management
Educational program	"Geodesy and Land Management"
Faculty	Land Management
Developers	Associate prof., PhD, Drozdivskyi O.P.
	Associate prof., PhD, Moskalenko A.A.

Kyiv – 2023

1. Description of the discipline

Geoinformation systems and databases

Branch of knowledge, direction of education, specialty, educational-qualification level (EQL)		
Educational qualification level	Bachelor	
Specialty	193 Geodesy and Land management	
Educational program	Geodesy and Land management	
Characteristics of the course		
Type	Normative	
Total hours	210	
ECTS credits	7,0	
Thematic modules	4	
Course project (work) (if exist)		
type of examination	Exam	
Indicators of the course for full-time and part-time forms of study		
	full-time study	by correspondence
year of training	3	
semester	5	
lectures	30 hours	
practical, seminar	- hours	
laboratory	45 hours	
self-dependent work	135 hours	
individual work	- hours	
amount of inclass work per week, hours	5 hours	

2. Purpose, objectives, and competencies of the course

Purpose of the discipline: The course "GIS and Database" provides the opportunity to use in program-technical complex for automated recording, storing, displaying, analyzing, modeling of spatially coordinated information and creating databases.

Objectives of course is forming as the specialist and subsequent practical use of technologies of GIS and databases is the task of study of discipline, in particular, geodatabase knowledge and practical skills of work on a computer in MS Access environment, and basic receptions of development and work, with the databases in MS Access.

Acquisition of competencies:

Integrated competency (IC)

IC. The ability to solve complex specialized problems of geodesy and land management

- general competencies:

GK 01. Ability to learn and master modern knowledge.

GK 02. Ability to apply knowledge in practical situations.

GK 05. Ability to communicate in a foreign language.

GK 06. Ability to use information and communication technologies.

GK 07. Ability to work autonomously.

GK 08. Ability to work in a team.

GK 13. Ability to preserve, multiply moral, cultural, scientific values and achievements of society based on understanding of history, patterns of development of the subject area, its place in the general system of knowledge about nature and society, as well as in the development of society, technology and technology. activities for recreation and healthy living

- professional (special) competencies (PC):

SC 01. Ability to apply fundamental knowledge to analyze phenomena of natural and man-made origin in the performance of professional tasks in the field of geodesy and land management.

SC 03. Ability to apply regulations, regulatory and technical documents, reference materials in professional activities.

SC 04. Ability to choose and use effective methods, technologies and equipment for professional activities in the field of geodesy and land management.

SC 05. Ability to use modern information, technical and technological support to address complex issues of geodesy and land management.

SC 06. Ability to perform remote, ground, field and in-house research, engineering calculations for processing research results, prepare research results, prepare reports in solving problems of geodesy and land management.

SC 07. Ability to collect, update, process, critically evaluate, interpret, store, publish and use geospatial data and metadata on objects of natural and man-made origin.

SC 08. Ability to carry out professional activities in the field of geodesy and land management, taking into account the requirements of professional and civil safety, labor protection, social, environmental, ethical, economic aspects.

SC 09. Ability to use tools, instruments, equipment, facilities in the performance of geodetic and land management tasks.

SC 10. Ability to monitor and evaluate land.

Program learning outcomes (PLO)

LR 1. Fluent in oral and written forms in state and foreign languages on professional matters.

LR 2. Organize and manage the professional development of individuals and groups.

LR 3. Communicate information, ideas, problems, solutions, personal experience and arguments to specialists and non-specialists.

LR 4. To know and apply in professional activity normative-legal acts, normative-technical documents, reference materials in the field of geodesy and land management and related branches.

LR 9. Collect, evaluate, interpret and use geospatial data, metadata on objects of natural and man-made origin, apply statistical methods of their analysis to solve specialized problems in the field of geodesy and land management.

LR 10. Choose and apply tools hardware, hardware and software supplies needed for remote, ground, field and in-house research in in the field of geodesy and land management.

LR 11. Organize and execute remote, ground, field and camera works in the field of geodesy and land management, draw up the results of work, prepare relevant reports.

LR 13. Plan and execute geodetic, topographic and cadastral surveys, process the results in geographic information systems.

LR 14. Plan a complex professional activity, develop and implement projects in the field of geodesy and land management under conditions resource and other constraints.

LR 15. Develop and adopt effective decisions on professional activities in the field geodesy and land management, including under conditions uncertainty.

3. Program and structure of the course for:
– complete full-time (part-time) form of study;

Modules and topics	Hours											
	full-time study							correspondence				
	weeks	total	including					total	including			
			l	p	lab	ind	s.w.		l	p	lab	ind
1	2	3	4	5	6	7	8	9	10	11	12	13
SEMANTIC MODULE I. Basics of Geoinformation systems and tecnologies												
Theme 1. Introduction to Geoinformation science	1	16	2		4		10					
Theme 2. Model of spatial data: vector and object data models	2	23	2		6		15					
Theme 3. Model of spatial data. Mosaic models	3	21	2		4		15					
Total by Semantic module 1		***60***	***6***		***14***		***40***					
SEMANTIC MODULE II. Modern technology of databases												
Theme 4. Basic concepts and determination of database theory	4	14	1		2		10					
Theme 5. Stages of database design	4	6	1		4							
Theme 6. Database system concepts and architecture	5	30	2				30					
Theme 7. Data modeling using the entity-relationship model	6	4	2		2							
Theme 8. Relational database design	7	6	2		4							
Total by Semantic module 1		***60***	***8***		***12***		***40***					
SEMANTIC MODULE III. Database design												
Theme 9. Normalization as way to control of database structure. Normal forms 1-3	8	22	2		2		18					
Theme 10. Normalization. The heist normal forms	9	4	2		2							
Theme 11. Modern database methodology infological design	10	4	2		2							
Total by Semantic module 1		***30***	***6***		***6***		***18***					
SEMANTIC MODULE IV. Operation with data												
Theme 12. Relational algebra	11-12	21	4		6		20					
Theme 13. Operation and query languages	13-15	39	6		7		17					
Total by Semantic module 2		***60***	***10***		***13***		***37***					
Усього годин		**210**	**30**		**45**		**135**					

4. Seminar topics

№	Topic	Hours

5. Practical class topics

№	Topic	Hours

6. Laboratory class topics

№	Topic	Hours
1	Creation of layers of geospatial data	2
2	Determination of the design boundary of the geospatial data base	2
3	Vectorization. Part 1	2
4	Vectorization. Part 2	2
5	Vectorization. Part 3.	2
6	Editing vector layers.	4
7	Forming a technical task for designing a geospatial database	2
8	Entering attribute data. Part 1	2
9	Entering attribute data. Part 2	2
10	Creation of a conceptual model of the database	2
11	Creating a logical database model. Part 1	2
12	Creating a logical database model. Part 2	2
13	Normalization. Part 1	2
14	Normalization. Part 2	2
15	Normalization. Part 3	2
16	Creating a physical database model	4
17	SQL query language. Part 1	2
18	SQL query language. Part 2	2
19	Calculation of secondary attributes of subject area objects. Creation of new object classes	2
20	Client-server architecture in the formation of requests to the database	3
Total		**45**

7. Independent work topics

№	Topic	Hours
1	Analysis of publications on the basics of geoinformation systems and technologies	10
2	Creating geospatial data layers in QGIS	15
3	Raster base vectorization in QGIS	15
4	Overview of database design software	10
5	Installation of software for working with databases.	15
6	Setting up software for working with databases.	15
7	NoSQL database technologies	18
8	Procedural programming languages when working with SQL	20
9	Functions used in SQL databases	17
Total		**135**

8. Samples of control questions, tests for assessing the level of knowledge acquisition by students.

1. What is GIS?
2. How to relate information using GIS?
3. Define the elements of a GIS.
4. What is Raster Method?
5. Define GIS and other information systems.
6. Define Data Representation and Projection in GIS.
7. What is a Database?
8. What is a Database Management System (DBMS)?
9. Define the classification of databases.

10. What is data models?
11. What is a Database System Concepts?
12. What is a Schema construct?
13. Define the Categories of Data Model.
14. What is Database languages and interfaces?
15. What is a Database design?
16. What is a Conceptual Database Design?
17. Define the Basic stages of planning of database.
18. What is Physical Database Design?
19. Define the Steps in Database Design.
20. What is a Relational model concepts?
21. What is a Constraints?
22. Define the Relational model constraints and relational DB schemas.
23. Discuss each of the following concepts in the context of the relational data model: (a) relation; (b) attribute; (c) domain; d) tuple; (e) intension and extension; (f) degree and cardinality.
24. Describe the relationship between mathematical relations and relations in the relational data model.
25. Describe the differences between a relation and a relation schema. What is a relational database schema?
26. Discuss the properties of a relation.
27. Discuss the differences between the candidate keys and the primary key of a relation. Explain what is meant by a foreign key. How do foreign keys of relations relate to candidate keys? Give examples to illustrate your answer.
28. What is data model? What is attribute?
29. What are structural constraints?
30. What kind of information does the cardinality ratio give us?
31. In how many different ways can two entities be involved in a cardinality relationship? Give examples.
32. What kind of information does the participation constraint give us?
33. Is it always necessary to have cardinality ratios as well as participation constraints in the same ER diagram? Why? Explain.
34. Define the five basic relational algebra operations. Define the Join, Intersection, and Division operations in terms of these five basic operations.
35. Discuss the differences between the five Join operations: Theta join, Equijoin, Natural join, Outer join, and Semi join. Give examples to illustrate your answer.
36. Compare and contrast the tuple relational calculus with domain relational calculus. In particular, discuss the distinction between tuple and domain variables.
37. What is the difference between a procedural and a non-procedural language? How would you classify the relational algebra and relational calculus?
38. What are the advantages and disadvantages of SQL?
39. Explain the function of each of the clauses in the SELECT statement. What restrictions are imposed on these clauses?
40. What restrictions apply to the use of the aggregate functions within the SELECT statement? How do nulls affect the aggregate functions?
41. Explain how the GROUP BY clause works.
42. What is functional dependency?
43. What does the term unnormalized relation refer to?
44. How did the normal forms develop historically from first normal form up to Boyce-Codd normal form?
45. Define first normal form.
46. Define second normal form.
47. Define third normal form.
48. Define Boyce-Codd normal form.

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ			
ОС «Бакалавр» спеціальність 193.Геодезія та землеустрій	Кафедра Геоінформатики і аерокосмічних досліджень Землі 2023/2024 н.р.	**Екзаменаційний білет №1** з дисципліни «GIS and databases»	ЗАТВЕРДЖУЮ Т.в.о. зав.кафедри _____ (підпис) Дроздівський О.П. «14» квітня 2023р.

Екзаменаційні питання

1. Define the five basic relational algebra operations. Define the Join, Intersection, and Division operations in terms of these five basic operations.

2. How to relate information using GIS?

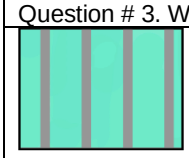
3. Discuss each of the following concepts in the context of the relational data model: (a) relation; (b) attribute; (c) domain; d) tuple; (e) intension and extension; (f) degree and cardinality.

Тестові завдання різних типів

Question # 1. What are components of the Geographic Information System?	
1	Hardware
2	Software
3	Requirements
4	Data
5	People
6	Analysis

Question # 2. Combine correctly			
1	Logical Database Design	A	1 step
2	Requirement Analysis	B	none
3	Physical Database design	C	2 step
4	Prototyping	D	4 step
5	Conceptual Database Design (ER-Diagram)	E	3 step

Question # 3. Which type operation of relation algebra is shown on the figure?



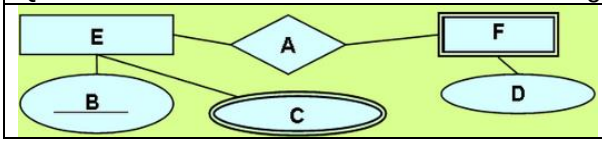
1	Intersection
2	Projection
3	Selection
4	Set Difference
5	Union

Question # 4. Combine correctly			
1	String types	A	DATE
2	String types	B	CHARACTER
3	Numeric types	C	FLOAT
4	Numeric types	D	NUMBER
5	Numeric types	E	LONG
6	Date/time type	F	INTEGER

Question # 5. What is the smallest unit of vector formats?	
1	points
2	pixel
3	lines/arcs/routes
4	areas/polygons/regions
5	behavior

Question # 6. Combine correctly			
1	piece of information collected and formatted in a specific way	A	Data element
2	the smallest unit of information that can be understood (or perceived) by an end user	B	Data Model
3	the logical data structures, including operations and constraints provided by the DBMS to effectively process data	C	Data

Question # 7. Specify the correct sequence of database design process			
1	First step	A	Conceptual Database Design
2	Second step	B	Physical Database design
3	Third step	C	Logical Database Design
4	Fourth step	D	Requirement Analysis

Question # 8. Choose KEY ATTRIBUTE in the figure


Question # 9. Attributes can be:	
1	Simple
2	Composite
3	Single
4	Foreing
5	Derived

Question # 10. What is the smallest unit of raster formats?	
1	pixel
2	point
3	lines/arcs/routes
4	areas/polygons/regions
5	behavior

9. Teaching methods

In conducting lectures appropriate to use verbal teaching methods: explanation, narration, discussion, educational debate, with a combination of visual learning methods: illustration, showing.

In carrying out laboratory work should be used such as verbal learning method of instruction on the combination of visual learning methods of illustration and demonstration, the aspect of these studies is that they facilitate communication theory and practice, providing students acquiring skills using standard and specialized software, application of information technology to cadastral and form students' initial skills of research activities. Laboratory work in the laboratory are equipped computers.

10. Forms of assessment

Module number	Module name	Theme Lecture	Theme of laboratory lesson	Form of control
I	Basics of Geoinformation systems and tecnologies	Theme 1. Introduction to Geoinformation science	Creation of layers of geospatial data	Protection of laboratory work / assessment of modular control work
			Determination of the design boundary of the geospatial data base	
		Theme 2. Model of spatial data: vector and object data models	Vectorization. Part 1	
			Vectorization. Part 2	
			Vectorization. Part 3.	
		Theme 3. Model of spatial data. Mosaic models	Editing vector layers.	
II	Modern technology of databases	Theme 4. Basic concepts and determination of database theory	Forming a technical task for designing a geospatial database	Protection of laboratory work / assessment of modular control work
		Theme 5. Stages of database design	Entering attribute data. Part 1	
			Entering attribute data. Part 2	
		Theme 6. Database system concepts and architecture	Creation of a conceptual model of the database	
		Theme 7. Data modeling using the entity-relationship model		
		Theme 8. Relational database design	Creating a logical database model. Part 1	
			Creating a logical database model. Part 2	
III	Database design	Theme 9. Normalization as way to control of database structure. Normal forms 1-3	Normalization. Part 1	Protection of laboratory work / assessment of modular control work
		Theme 10. Normalization. The heist normal forms	Normalization. Part 2	
		Theme 11. Modern database methodology infological design	Normalization. Part 3	

IV	Operation with data	Theme 12. Relational algebra	Creating a physical database model	Protection of laboratory work / assessment of modular control work
		Theme 13. Operation and query languages	SQL query language. Part 1	
			SQL query language. Part 2	
			Calculation of secondary attributes of subject area objects. Creation of new object classes	
			Client-server architecture in the formation of requests to the database	

The main methods of control of knowledge and skills students have to study the subject " Geoinformation systems and databases" are: oral examination, written and practical test, standardized control in the form of modular test papers, assessment for individual learning task, the final test.

The total value of these methods is to make the best possible to ensure timely and comprehensive feedback between students and teachers, by which establishes how students perceive and learn the material.

The purpose determines the choice of control methods, it should be borne in mind that these methods can be applied in all kinds of control - only complete applications allows regularly and objectively identify the dynamics of the formation of knowledge and skills of students. Each control method has its advantages and disadvantages, scope of application, none of them can not be the only one able to diagnose all aspects of the learning process. So:

- to control the absorption of lectures: oral questioning, written modular test papers, current testing score for an individual learning task, the final test.
- for the monitoring and evaluation of laboratory work: practical test and evaluation of each laboratory work.

11. Distribution of grades received by students

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023, protocol №10)

Student rating, points	**National grade based on exam results**	
	Exams	**Credits**
90-100	**Excellent**	**Passed**
74-89	**Good**	
60-73	**Satisfactory**	
0-59	**Unsatisfactory**	**Not passed**

In order to determine the rating of a student (listener) in the discipline $\mathbf{R_{dis}}$ (up to 100 points), the rating from the exam $\mathbf{R_{ex}}$(up to 30 points) is added to the rating of a student's academic work $\mathbf{R_{aw}}$ (up to 70 points): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$ **.**

Rating evaluations system of educational work for the substance modules

	Type of work	Module				Course	
		point by work	percent by		total	percent by modules	total
			work	module			
Module # 1	Laboratory work #1	100	10 %	70 %	100	20 %	100
	Laboratory work #2	100	10 %				
	Laboratory work #3	100	5 %				
	Laboratory work #4	100	10 %				
	Laboratory work #5	100	10 %				
	Laboratory work #6	100	10 %				
	Independent work #1	100	5 %				
	Independent work #2	100	5 %				
	Independent work #3	100	5 %				
	Module test / control	100	30 %	30 %			
Module # 2	Laboratory work #7	100	10 %	70 %	100	20 %	
	Laboratory work #8	100	10 %				
	Laboratory work #9	100	10 %				
	Laboratory work #10	100	10 %				
	Laboratory work #11	100	5 %				
	Laboratory work #12	100	10 %				
	Independent work #4	100	5 %				
	Independent work #5	100	5 %				
	Independent work #6	100	5 %				
	Module test / control	100	30 %	30 %			
Module # 3	Laboratory work #13	100	20 %	70 %	100	10 %	
	Laboratory work #14	100	20 %				
	Laboratory work #15	100	20 %				
	Independent work #7	100	10 %				
	Module test / control	100	30 %	30 %			
Module # 4	Laboratory work #16	100	10 %	70 %	100	20 %	
	Laboratory work #17	100	10 %				
	Laboratory work #18	100	15 %				
	Laboratory work #19	100	10 %				
	Laboratory work #20	100	15 %				
	Independent work #8	100	5 %				
	Independent work #9	100	5 %				
	Module test / control	100	30 %	30 %			
Final test		100				30 %	

12. Educational and methodological support

1. Кохан С.С., Москаленко А.А., Іванюта О.О. Geoinformation systems and databases (a series of lectures) для студентів напряму підготовки «Геодезія, картографія та землеустрій» - К.: ЦК «КОМПРИНТ»,2014.

2. Кохан С.С., Москаленко А.А., Іванюта О.О. Geoinformation systems and databases (methodological guideline for laboratory classes) для студентів напряму підготовки «Геодезія, картографія та землеустрій» - К.: ЦК «КОМПРИНТ», 2014.

13. Recommended literature Recommended sources of information

Basic:

1. Allen Taylor. SQL For Dummies, 9th edition. 2020 – 544p.

2. Database Systems: A Practical Approach to Design, Implementation, and Management Third Edition / Thomas Connolly, Carolyn Begg. 2014 – 1440 p.
3. Ekmasri, R. and Navatane, S.B. Fundamentals of Database Systems, 7th ed., Addison-Wesly, Reading, Boston, MA, 2017
4. Geographic information systems / M. Van Meirvenne, Svitlana Kokhan, roman Ananchenko, NAUU, 2003
5. Геоінформаційні системи і бази даних: монографія / В. І. Зацерковний, В. Г. Бурачек, О. О. Железняк, А. О. Терещенко. – Ніжин: НДУ ім. М. Гоголя, 2014. – 492 с.

Additional:
6. Інформатика та комп'ютерна техніка: Навч.-метод. посібник / За заг. ред. О.Д. Шарапова. – К.: КНЕУ, 2002.
7.Sikha Bagui, Richard Earp. Database design using Entity-Relationship Diagrams, CRC Press, RBoca Raton, Florida, 2000.
8. A Moskalenko (2021) GIS support of forming spatial decisions on land use. Mechanization in agriculture & Conserving of the resources 67 (3), 79-81.
9. ISO/TS 19104:2008 «Geographic information – Terminology».
10. ISO 19107:2003 «Geographic information - Spatial schema».
11. ISO 19108:2002 «Geographic information - Temporal schema»
12. ISO 19110:2005 «Geographic information - Methodology for feature cataloguing»
13. ISO 19115 «Geographic information - Metadata»

14. Information resources:

1. eLearn webpage - https://elearn.nubip.edu.ua/course/view.php?id=1554
2. eLearn webpage - https://elearn.nubip.edu.ua/course/view.php?id=158
3. Мулеса О.Ю. Інформаційні системи та реляційні бази даних. Навч. посібник. – Електронне видання, 2018. –118 с.
4. Геоінформаційні системи (ГІС). Портал знань. Електронні навчальні курси. Дистанційне навчання. Режим доступу - http://www.znannya.org/?view=gis
5. Стандарти та специфікації відкритого геопросторового консорціуму OGC, http://www.opengeospatial.org/standards