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

REMOTE SENSING FOR LAND RESOURCES MONITORING

Specialization	193. Geodesy and Land management
Educational program	"Geodesy and Land Management"
Faculty	Land Management
Developers	Dr. Sci., Prof. Kokhan S.S.

Kyiv – 2023

1. Description of the course

"Remote sensing for land resources monitoring"

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Bachelor's*	
Specialization	*193 Geodesy and Land management*	
Educational program	*Geodesy and Land management*	
Description of the course		
Type	Compulsory	
Total number of hours	75	
Number of ECTS credits	2,5	
Number of content modules	2	
Course project (work) (if applicable)		
Form of assessment	*Credit*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Course (year of study)	*4*	-
Semester	*7*	-
Lecture classes	*15 hr.*	-
Practical, seminar classes	-	-
Laboratory classes	*30 hr.*	-
Self-study	*30 hr.*	-
Individual assignments	-	-
Number of weekly classroom hours for the full-time form of study	*3 hr.*	

2. Purpose, objectives, and competencies of the course

Purpose: To learn the concepts of remote sensing and to get practical skills of previous and thematic geoprocessing to be used in land management and cadaster.

Objectives:

- to learn main theoretical concepts of remote sensing and receiving remote sensing data;
- to learn general characteristics of optical sensors;
- to get skills of using methods of digital image processing.

As a result, learning of educational discipline "Remote sensing for land resources monitoring" student needs to:

KNOW

- tasks, which are solved with the use of remote sensing data;
- ways to get remote sensing data;
- technology of acquisition and processing of remote sensing data

BE ABLE

- to identify classes of objectives based on visual features with the use of multispectral satellite imagery of high and medium spatial resolution;
- to create spectral signatures based on remote sensing data;

- to make application for surveying and obtaining information based on satellite imagery and UAV's images;
- to use software for processing of remote sensing data to solve current tasks of land management and monitoring of land resources;

TO BE AWARE OF

- perspective researches in remote sensing;
- using remote sensing data in land management.

Acquisition of competencies:

General competencies (GC):

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 10. Ability to exercise safe activity.

GK 11. Ability to carry out geodetic monitoring of the earth's surface, natural objects, engineering structures.

GK 12. The ability to exercise their rights and responsibilities as a member of society; awareness values of civil (free democratic) society and its necessity sustainable development, the rule of law, rights and human and civil liberties in Ukraine.

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.

SC 12. Ability to conduct technical control and assess the quality of topographic, geodetic and cartographic products.

SC 13. Ability to develop documentation on land management and land valuation, cadastral documentation, fill in the data of state land, urban and other cadastres

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 7. Perform surveys and survey, topographic and geodetic, cartographic, design and design and survey work in the performance of professional tasks in geodesy and land management.

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 12. Develop documentation from land management, cadastral documentation and land valuation documentation with application computer technology, geoinformation systems and digital photogrammetry, to fill the state land with data, urban and other cadasters.

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

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;

– shortened full-time (part-time) form of study.

Names of content modules and topics	Number of hours												
	Full-time form							Part-time form					
	weeks	total	including					total	including				
			l	p	lab	ind	self		l	p	lab	ind	self
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Content Module 1. **Concept of remote sensing**													
Topic 1. Introduction. Concepts of remote sensing of the Earth. Electromagnetic radiation.	1-4	15	2		8		5						
Topic 2. Visual interpretation of objects.	5-6	6	2		4								
Topic 3. Classification of methods of remote sensing. Sensor systems.	7	15	2				8						
Topic 4. Image acquisition. Data formats. Standards in remote sensing.	8	7	2		3		2						
Total for content module 1	**38**		**8**		**15**		**15**						
Content Module 2. **Digital image analysis**													
Topic 1. Preprocessing of remotely sensed data.	9-10	5	2		3								
Topic 2. Image georeferencing and image transformation	10	8	1		2		5						
Topic 3. Image acquisition based on Unmanned Aerial Vehicles (UAVs).	11-12	4	2				2						
Topic 4. Image classification	13-15	18	2		8		10						
Total for content module 2	**37**		**7**		**15**		**15**						
Total hours	**75**		**15**		**30**		**30**						
Course project (work) on _____ _____ **(if included in the curriculum)**			-	-	-		-		-	-	-		-
Total hours	**75**		**15**		**30**		**30**						

4. Seminar topics

5. Practical class topics

6. Laboratory lessons

№	Topic title	Number of hours
1.	Visual interpretation of image elements in various spectral channels. Interpretation of recognized objects.	8
2.	Measurement of spectral brightness of objects	4
3.	Radiometric image enhancement	3
4.	Image resampling	2

5.	Unsupervised classification	3
6	Training sites. Signature comparison chart.	3
7	The quality of training sites. Application of algorithms of image classification based on hard rules	7
	Total	**30**

7. Independent work topics

№	Topic title	Number of hours
1.	Professional terminology in remote sensing of the Earth	5
2	Image interpretation	8
3.	Remote sensing data acquisition	2
4.	Image georeferencing and image transformation	5
5	Preprocessing of remotely sensed data	3
6	Image acquisition based on Unmanned Aerial Vehicles (UAVs)	2
7	Image classification	15
	Total	**30**

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

Samples of control questions

1. Classification of methods of remote sensing.
2. Electromagnetic radiation and its spectra.
3. Plants spectral signatures.
4. Factors that rely acquisition of spectral data.
5. Classification of sensor systems.
6. Photographic image, its acquisition and characteristics.
7. Digital images and their characteristics.
8. Spatial resolution of sensors.
9. Radiometric resolution.
10. Spectral and temporal resolution of sensors.
11. Satellite systems with high spatial resolution and their characteristics.
12. Satellite systems (Landsat, Deimos, Sentinel, SPOT, Pleiades). Their technical characteristics and application of imagery.
13. Radar satellite systems.
14. Pre-processing of images. Radiometric correction.
15. Pre-processing of images. Geometric correction.
16. Pre-processing of images. Atmospheric correction.
17. Stages of supervised classification.
18. Unsupervised image classification.
19. Classification decision rule
20. Training sites and their quality.
21. Maximum likelihood classifier
22. Liner discriminant function
23. Minimal spectral distance classifier
24. Parallelepiped classification

25.KNN classifier.
26.Classification accuracy assessment
27.Explain the process of obtaining remote sensing data?
28.What are formats of satellite images?
29.What are platforms for remote sensor?
30.What is the role of ground-based sensors?
31.What sensor characteristics do you know?
32.Explain the mission of the satellite Landsat?
33.Explain characteristics and missions of modern satellite systems?
34.What are the steps of digital image interpretation?
35.What is geometric registration process?
36.What is spectral pattern recognition?
37.What is classification?
38.Tell characteristics of algorithms for supervised classification?
39.What is separability of classes?
40.Explain the role of statistics in digital image analysis?
41.Explain the differences between soft and hard classifiers7
42.How to estimate accuracy of classification?
43.Bayesian classifier application.

Tests for assessing the level of knowledge acquisition by students

National University of Life and Environmental Sciences of Ukraine of Ukraine			
Educational laevel Bachelor 193.Geodesy and land management	Department of Geoinformatics and Aerospace Research of the Earth 2023/2024	**Ticket 1**	Approved Head of the department _____ «__» _____2023 Protocol № ___

1 Explain the sensor locations?
2 What are the main sensor characteristics?
3 What are the satellite image resolution types?
4 Explain the necessity of pre-processing of remote sensing data
5 What is training site? Explain rules for obtaining training sites?
6 Why the classification is “supervised”? Give an explanation?
7 Stages of supervised classification

8	What is atmospheric correction?

9	Give the name of sensor characteristic?
	A measure of the sensitivity of sensors to the recognition of gradations of brightness?

10	Give the name of the procedure:
	Based on the brightness values of the sample pixels, the parameters of the scattering ellipses are calculated

11	What is the name of the stage, that consists in the calculation and analysis of some set of statistical characteristics of pixel values of test polygons?

12	What information about objects is taken into account when performing supervized classification?

13	What ranges of electromagnetic radiation are used in remote sensing:
1	0,1–1 мм, 1–10 мм, 1-10 см, 0,1–1 м
2	100А–0,4 мкм
3	8–14 мкм
4	0,3–0,4 мкм, 0,4–0,7 мкм, 0,7–14 мкм, 1 мм–1 м

14. Select the values of spatial resolution of these systems:			
1	World View 3	A	0.67 m
2	NOAA/AVHRR	B	0.7 m
3	EROS B	C	1100 m
4	Pleiades	D	0.31 m

15. Select the temporal resolution of systems:			
1	Meteosat	A	12 hours
2	Landsat 8 OLI	B	1 day
3	Ikonos	C	3 days
4	SPOT 7	D	16 days
5	NOAA	E	30 minutes

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	Chapter of the discipline	Topic	Laboratory lesson	Form of control
I	Concept of remote sensing	Concepts of remote sensing of the Earth. Electromagnetic radiation	Visual interpretation of image elements in various spectral channels. Interpretation of recognized objects.	Defense of laboratory lessons/ Module test
		Visual interpretation of objects.	Measurement of spectral brightness of objects	

		Classification of methods of remote sensing. Sensor systems.		
		Image acquisition. Data formats. Standards in remote sensing	Radiometric image enhancement	
II	Digital image analysis	Preprocessing of remotely sensed data		Defense of laboratory lessons / Module test
		Image georeferencing and image transformation	Image resampling	
		Image acquisition based on Unmanned Aerial Vehicles (UAVs).		
		Image classification.	Unsupervised classification Procedure of supervised classification. Training sites. Signature comparison chart. The quality of training sites. Application of algorithms for image classification based on hard rules	

The main methods of control of knowledge and skills students have to study the subject "Remote sensing for land resources monitoring" 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 "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): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$ **.**

12**. Educational and methodological support.**

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2. Географічні інформаційні системи / За ред. М. Ван Мервіна, С.С. Кохан. – К., 2003. – 208 с.
3. Основи ГІС-аналізу: навч. посібник / В. Д. Шипулін ; Харк. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Х.: ХНУМГ, 2014. – 330 с.
4. Kokhan S.S., Vostokov A.B. Remote Sensing Land Resources Monitoring. Manual for bachelor students of the direction of training “Geodesy, cartography and land management”.−K: Komprint.−2014.−303 p.

13**. Recommended sources of information**

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7. Кохан С.С., Востоков А.Б. Моделі передачі випромінювання в системі «грунт-рослина». –Корсунь-Шевченківський.-2013.-169 с.
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11. https://www.g2.com/articles/gis-mapping. 2019
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14. Fundamentals of Database Systems, 7th/E Ramez Elmasri, University of Texas at Arlington Shamkant B. Navathe, Georgia Institute of Technology, 2017
15. Khaiter P.A. Conceptualizing an Environmental Software Modeling Framework for Sustainable Management Using UML / P.A. Khaiter, M.G. Erechtchoukova // Journal of Environmental Informatics. – 2019. – 34 (2). – pp. 123-138.
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27. ISO 19107:2003 «Geographic information - Spatial schema».
28. ISO 19108:2002 «Geographic information - Temporal schema»

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