NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of geographic information systems and technologies

APPROVED
Dean of the Faculty of Land management
Ievsiukov T.O.
19 May 2022 year

APPROVED
at a meeting of the Department of Geoinformatics
and Aerospace Research of the Earth
Minutes № 12 of 27 April 2022
Head of Department
Kokhan S.S.

AGREED
Guarantor of the educational program
Kovalchuk I.P.

THE WORK PROGRAMM OF EDUCATIONAL DISCIPLINE

REMOTE SENSING FOR LAND RESOURCES MONITORING

Field of knowledge	19. Architecture and Construction
Specialty	193. Geodesy and Land management
Educational program	"Geodesy and Land Management"
Faculty	Land Management
Authors	Dr. Sci., Prof. Kokhan S.S.

Kyiv – 2022

1. Description of the discipline
REMOTE SENSING FOR LAND RESOURSES MONITORING

Branch of knowledge, direction of education, specialty, educational level (EQL)		
Educational qualification level	Bachelor	
Specialty	193 Geodesy and Land management	
Educational program	Geodesy and Land management	
Description of the course		
Type	Selected	
Total hours	90	
ECTS credits	3.0	
Thematic modules	2	
Course project (work) (if yes)		
type of examination	test	
Indicators of discipline for full-time and distance learning		
	full-time study	by correspondence
year of training	4	-
semester	8	-
lectures	15 hours	-
practical lessons, seminars		-
laboratory lessons	30 hours	-
self-dependent work	45 hours	-
individual work	-	-
amount of self-dependent work per week, hours	3 hours	

2. Purpose and tasks of the discipline

"Remote sensing for land resources monitoring"

Aims:

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.

Tasks:

- 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.

The discipline provides the formation of a number of competencies:

- **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 10. Ability to exercise safe activity.

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

- **special competencies:**

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

Normative content of training of higher education seekers, formulated in terms of learning outcomes

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 of the discipline

MODULE 1. CONCEPT OF REMOTE SENSING

Lecture 1. Concepts of remote sensing of the Earth. Electromagnetic radiation.

Tasks of the course. Historical overview of methods of remote sensing of the Earth.

Electromagnetic radiation and diapason of waves. Optical diapason. Relationship of electromagnetic radiation with atmosphere.

Reflectance and coefficient of reflectance.

Spectral reflectance. Analysis of factors influenced on spectral reflectance. Spectral reflectance of green leaves and main classes of natural objects. Chemical soil properties and spectral reflectance.

Lecture 2. Visual interpretation of objects.

Direct elements of image interpretation. Direct recognition. Geometric, brightness's, structural elements of visual image interpretation. Shape, shadow, size, tone, pattern of the image. Indirect elements of image interpretation.

Lecture 3. Classification of methods of remote sensing. Sensor systems.

Digital image format. Classification of methods of remote sensing of the Earth. Sensor systems: main characteristics of sensors represented by spatial, radiometric, temporal and spectral resolution.

Classification of imagery by spectral diapason. Image interpretation keys for identification features with Landsat ETM+.

Lecture 4. Image acquisition. Data formats. Standards in remote sensing.

Sensors of high spatial resolution. Application of high-resolution images in land management and land cadastre (GeoEye, WorldView-3/4, Ikonos).

Satellite data for monitoring of land resources and agricultural resources (SPOT-6/7, Landsat ETM+/Landsat 8, Sentinel, Deimos, Pleiades).

MODULE 2. DIGITAL IMAGE ANALYSIS.

Lecture 1. Preprocessing of remotely sensed data.

Set of specialized techniques and computer processing tools for digital image processing. Calibration, radiometric correction, geometric correction. Destripe. Filters.

Lecture 2. Image georeferencing and image transformation.

Image georeferencing. Geometric models for coordinate transformation. Control points. Affine model. Nonlinear methods of transformation.

Lecture 3. Image acquisition based on Unmanned Aerial Vehicles (UAVs).

Digital aerial cameras for UAVs. Cameras with separate lenses and matrices for each spectral channel. Cameras with one lens and matrix. Bayer matrix. Types of sensors. Multispectral cameras.

Lecture 4. Image classification.

Unsupervised classification and its application.

Supervised classification. Training sites. Minimal number of pixels to providing classification. Demands for quality of training sites.

Classification decision rule. Algorithms of supervised classification. Method of minimal spectral distance. Method of maximum likelihood. Method of linear discriminant.

4. Structure of the discipline

«Remote sensing for land resources monitoring»

Modules and topics	Hours											
	Full-time						by correspondence					
	total	included					Total	included				
		Total	L	P	Lab	Ind		L	P	Lab	Ind	Self work
1	2	3	4	5	6	7	8	9	10	11	12	13
MODULE 1. CONCEPT OF REMOTE SENSING												
Lecture 1. Introduction. Concepts of remote sensing of the Earth. Electromagnetic radiation.	1-4	15	2		8	5						
Lecture 2. Visual interpretation of objects.	5-6	6	2		4							
Lecture 3. Classification of methods of remote sensing. Sensor systems.	7	15	2			13						
Lecture 4. Image acquisition. Data formats. Standards in remote sensing.	8	7	2		3	2						
Together with Module 1	**8**	43	8		15	20						
MODULE 2. DIGITAL IMAGE ANALYSIS												
Lecture 1. Preprocessing of remotely sensed data.	9-10	5	2		3							
Lecture 2. Image georeferencing and image transformation	10	8	1		2	5						
Lecture 3. Image acquisition based on Unmanned Aerial Vehicles (UAVs).	11-12	4	2		2							
Lecture 4. Image classification	13-15	30	2		8	20						
Together with Module 2	15	47	7		15	25						
Total	**15**	**90**	**15**		**30**	**45**						

7. Topics of laboratory lessons

№	Topic	Hours
1	2	3
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.	Image resampling for UAV's data	2
6	Unsupervised classification	2
7	Procedure of supervised classification. Training sites. Signature comparison chart. The quality of training sites. Application of algorithms for image classification based on hard rules	9
	Total	**30**

8. Self-dependent work

№	Topic	Hours
1	2	3
1.	Professional terminology in remote sensing of the Earth	5
2	Visual image interpretation	13
3.	Remote sensing data acquisition	2
4.	Image georeferencing and image transformation	5
5.	Image classification	20
	Total	**45**

9. 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.

10. Methods of teaching

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.

11. Forms of control

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.

12. Distribution of grades received by students during study

Current testing		Rating of educational work $R_{НР}$	Rating of additional work $R_{ДР}$	Negative Rating $R_{ШТР}$	Final test	Total amount of scores
Module 1	Module 2					
0-100	0-100	0-70	0-20	0-5	0-30	0-100

Students rating has determined by 100 mark scale. It has composed of rating of studied work (70 marks) and rating of attestation (test) – 30 marks. Each of modules has evaluated by 100 mark scale too. The form of laboratory lessons control is their execution and presentation.

Rating of studied work can be changed by rating of additional work (20 marks) or penal rating (negative) - 5 marks - at the decision of chair convention.

A STUDIED RATING (R_S) IS CALCULATED BY FORMULA:

$$R_S = 0.7 \times \left(R_M^1 + R_M^2 + R_M^3\right) + R_{Ad} + R_P$$

where R^1_M, R^2_M, R^3_M – rating of 1st, 2nd and 3d modules by 100 mark scale, R_{Ad} - rating of additional work and R_P – penal ratin.

Rating of attestation (R_{At}) is determined by 100 mark scale too.

A RATING OF DISCIPLINE (R_D) IS CALCULATED BY FORMULA:

$$R_D = R_S + 0.3 \times R_{At}$$

A students rating is transferred in national mark and ECTS.

Ratio between national and ECTS values and rating from the discipline

National value	Rating points
1	*2*
Excellent	**90 – 100**
Good	**74 – 89**
Satisfactory	**60 – 73**
Unsatisfactory	**0 – 59**

Distribution of value points for performing various learning activities of each module

	Type of work	Module				Course	
		Points for work	Percentage of lesson	Percentage of Module	Only points	The percentage of modules	Only
Module 1	Laboratory lesson №1	100	15%	90%	100	35%	100
	Laboratory lesson №2-1	100	15%				
	Laboratory lesson №-2-2	100	15%				
	Laboratory lesson №3	100	15%				
	Individual work №1	100	10%				
	Individual work №2	100	10%				
	Individual work №3	100	10%				
	Test module	100	10%	10%			
Module 2	Laboratory lesson №4	100	10%	90%	100	35%	
	Laboratory lesson №5-1A	100	5%				
	Laboratory lesson №5-1	100	10%				
	Laboratory lesson №5-2	100	10%				
	Laboratory lesson №6	100	10%				
	Laboratory lesson №7	100	15%				
	Individual work №4	100	10%				
	Individual work №5	100	10%				
	Test module	100	10%	10%			
final test		100				30%	

13. Recommended literature

Basic

1. 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.
2. Кохан С.С., Востоков А.Б. Дистанційний моніторинг земельних ресурсів. Навч. посібник.−К.: ЦП «КОМПРИНТ».−2018.−264 с.
3. Кохан С.С., Востоков А.Б. Дистанційне зондування Землі. Теоретичні основи.− К.: Вища шк.−2009.−511 с.
4. Remote sensing for GIS managers. Stan Aronoff. ESRI Press. Redlands, California.−2005.−486 p.
5. Кохан С.С., Востоков А.Б. Методи ДЗЗ. Навч. посібник.−К.: ЦП «КОМПРИНТ».−2021.−292 с.

6. Цифровая обработка изображений/ Р. Гонсалес, Р.Вудс.− М.: Техносфера, 2005.− 1071 с.
7. ДСТУ 4220-2003 Дистанційне зондування Землі з космосу. Терміни та визначення понять. // Держстандарт України.
8. ДСТУ 4758-2007 "Дистанційне зондування Землі з космосу: Оброблення даних: Терміни та визначення.
9. СОУ ISO 19136:2009 "Обмінний формат геопросторових даних на основі географічної мови розмітки GML (ISO 19136:2007)" // 30.09.2010
10. Аэрокосмические методы в почвоведении и их использование в сельском хозяйстве. – М.: Наука, 1990.− 247 с.

14. Additional resources

1. Zecha, C.W.; Peteinatos, G.G.; Link, J.; Claupein, W. Utilisation of Ground and Airborne Optical Sensors for Nitrogen Level Identification and Yield Prediction in Wheat. Agriculture 2018, 8, 79.
2. Kanning, M.; Kühling, I.; Trautz, D.; Jarmer, T. High-resolution UAV-based hyperspectral imagery for LAI and chlorophyll estimations from wheat for yield prediction. Remote Sens. 2018, 10, 2000.

15. Informational resources

1. Сайт законодавства України [електронний ресурс] – режим доступу: http://rada.gov.ua
2. https://elearn.nubip.edu.ua/course/view.php?id=1714/
3. Sensors 2019, 19, 4416; doi:10.3390/s19204416