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**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA (RUDN University)
named after Patrice Lumumba
Institute of Environmental Engineering**

COURSE SYLLABUS

Remote Sensing of MSW objects

Recommended by the Didactic Council for the Education Field for the specialization:
05.04.06 "Ecology and nature management"

The course instruction is implemented within the professional education programme of higher education:

«Integrated Solid Waste Management» (Network program with L.N. Gumilyov Eurasian National University)

1. COURSE GOAL(s)

The course is designed to help students the in-depth study of the method of remote sensing of the Earth and the features of its application for solving the problems of integrated management of production and consumption waste.

□ 2. REQUIREMENTS FOR COURSE OUTCOMES

The course implementation is aimed at the development of the following competences:
GC-7.1; GC -7.2; GC -7.3; PC-5.1; PC-5.2; PC-5.3

Competence code	Competence descriptor	Competence formation indicators (within this course)
GC-7	Able to use basic knowledge in the field of information culture	GC-7.1 Able to use basic knowledge in the field of information culture
		GC-7.2 Formulates a real data processing problem in terms of a real problem
		GC-7.3 Knows the principles and techniques of modern corporate information culture and the basics of the digital economy
PC-5	the ability to develop standard environmental measures and assess the impact of planned structures or other forms of economic activity on the environment	PC-5.1 Able to assess the impact on the environment of the designed enterprise and facilities, predict and evaluate the negative consequences
		PC-5.2 Able to develop standard environmental measures
		PC-5.3 Possesses the skills of environmental design and preparation of special documentation at the pre-project stage of the project life cycle

As a result of course studying, the student must:

Know:

- theoretical foundations of remote sensing;
- mechanisms and principles of the RSE images obtaining
- basic techniques for photointerpretation the remote sensing images;
- basic techniques of geoinformatics;

Be able to:

- use the methods of aero and space images photointerpretation to solve practical problems in the management of production and consumption waste;
- use the GIS software to solve practical tasks;
- use spectral indices to solve practical tasks
- use spatial analysis of territory to solve practical tasks;

Own :

- skills in working with design and engineering documentation;
- skills of working with normative - legal documentation.

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Discipline *Remote Sensing of MSW objects* refers to the **Electives** (block 1 of the curriculum).

Within the higher education programme students also master other disciplines (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course.

Table 3.1

The list of the higher education programme components that contribute to the achievement of the expected learning outcomes

Competence code	Competence descriptor	Previous courses/modules, internships*	Subsequent courses/modules, internships*
GC-7	Able to use basic knowledge in the field of information culture	IT in ecology and natural resources management	Research work in the term including projects / Industrial / pedagogical Internship Research work on thesis State Exam degree Diploma
PC-5	the ability to develop standard environmental measures and assess the impact of planned structures or other forms of economic activity on the environment	-	Research work in the term including projects / Industrial / pedagogical Internship Research work on thesis State Exam degree Diploma

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the discipline is **3** credit units.

Table 4.1. Types of academic activities during the period of the HE program(me) mastering

Types of academic activities		Total hours	Semester(s)			
			1	2	3	4
<i>Contact academic hours</i>						
Lectures		17			17	
Lab works		34			34	
Seminars (workshops/tutorials)						
<i>Self-study</i>		93			93	
<i>Evaluation and assessment (exam; pass/fail grading)</i>						
The total course workload	hours	144			144	
	credits	4			4	

5. COURSE CONTENT

Table 5.1. Course Modules and Contents

Title of Course Modules	Content	Types of academic activities
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1.	Introduction.	The study of the physical basics for Earth Remote Sensing, the study of types and means for remote sensing. Remote sensing data processing software: a variety of GIS, QuantumGIS interface, loading raster data, vector layers creation, Openstreetmaps, satellite images, georeferencing.	L, Lab
2	Basic principles of remote sensing, classification of remote sensing methods	Photointerpretation. photointerpretation signs. Features of recognition of artificial and natural objects. Semi-automatic classification. Multispec	L, Lab
3	Methods for solving problems using remote sensing and GIS tools	Remote sensing data processing software. GIS software diversity Types of problems solved with the help of GIS, Spatial analysis of GIS, a method for analyzing hierarchies. Vegetation indices, groups of vegetation indices	L, Lab L, Lab
	RSE methods to solve MSW tasks	Landfills. The main deciphering signs of unauthorized dumps. Methods for determining unauthorized dumps.	L, Lab
4		Geocomarketing	

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Classroom for Academic Activity Type	Classroom equipment	Specialized educational / laboratory equipment, software and materials for mastering the course (if necessary)
Lecture	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia

Seminars	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	projector, laptop, projection screen, stable wireless Internet connection. Software: Microsoft Windows, MS Office / Office 365, MS Teams, Chrome (latest stable release), Skype. Microsoft Windows 7 corporate. License No. 5190227, date of issue March 16, 2010 MS Office 2007 Prof , License # 6842818, date of issue 09/07/2009
Computer Lab	Computer Lab for conducting classes, group and individual consultations, current control and intermediate certification, equipped with personal computers (in the amount of 12), a board (screen) and technical devices of multimedia presentations.	QuantumGIS, Multispec
For Self-Study	Classroom for self-study (can be used for seminars and consultations), equipped with a set of devices includes laptop, stable wireless.	No

7. RECOMMENDED SOURCES FOR COURSE STUDIES

a) Main reading:

1. Martin Wegmann , Jakob Schwalb-Willmann , Stefan Dech An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software (Data in the Wild) 1st Edition, Kindle Pelagic Publishing, 2020
2. E.O. Wilson , Dawn J. Wright , Christian Harder GIS for Science, Volume 3: Maps for Saving the Planet. Esri Press, 2021, \$228
3. Jindong Li Satellite Remote Sensing Technologies Springer, Singapore, Space Science and Technologies, 2021 <https://link.springer.com/book/10.1007/978-981-15-4871-0>
4. Remote Sensing and Image Interpretation, 7th Edition, Thomas Lillesand , Ralph W. Kiefer , Jonathan Chipman <https://www.geokniga.org/bookfiles/geokniga-remote-sensingandimage-interpretation.pdf>
5. Ujaval Gandhi End-to-End Google Earth Engine (Full Course Material) A hands-on introduction to applied remote sensing using Google Earth Engine. <https://courses.spatialthoughts.com/end-to-end-gee.html>
6. Otto Huisman and Rolf A. de By Principles of Geographic Information Systems An introductory textbook The International Institute for Geo-Information Science and Earth Observation (ITC), webapps.itc.utwente.nl
7. Jonathan Campbell, Michael Shin, UCLA Essentials of Geographic Information Systems, Publisher: [Saylor Foundation](https://open.umh.edu/opentextbooks/formats/249) <https://open.umh.edu/opentextbooks/formats/249>

b) Additional reading

1. Jonathan Campbell, Michael Shin, UCLA Essentials of Geographic Information Systems, Publisher: Saylor Foundation <https://open.umh.edu/opentextbooks/formats/249>

2. T. Takagi, T. Oguchi, J. Matsumoto, MJ Grossman, MH Sarker, MA Matin (2007) Channel braiding and stability of the Brahmaputra River, Bangladesh, since 1967: GIS and remote sensing analyses, *Geomorphology* 85, 294–305.
3. John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, (Editors), 2001. Photogrammetric and remote sensing considerations; Chapter 16, *Manual of Geospatial Science and Technology*, Vol 1 Part 4 Pages 233 – 252
4. John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos (Editors), 2001. The remote sensing process: how do we collect the required in situ and remotely sensed data? Chapter 17, *Manual of Geospatial Science and Technology*, November 2001, Vol 1 Part 4 Pages 253 – 275K.
5. George Joseph: *Fundamentals of Remote Sensing*; Universities Press India Pvt Ltd, Hyderabad, India Editors: John D. Bossler; John R. Jensen; Robert B. McMaster; Chris Rizos, 2001. *Manual of Geospatial Science and Technology*, November 2001, Vol 1 Part 1 and II.

b) databases, information and reference and search systems, Internet sources:

1. Interregional public organization for promoting the development of the market for geoinformation technologies and services Web site of the GIS Association: <http://www.gisa.ru>
2. Association of developers, manufacturers and consumers of equipment and applications based on global navigation satellite systems "GLONASS / GNSS-Forum": <http://aggf.ru/>
3. Intersectoral journal of navigation technologies Vestnik GLONASS: <http://vestnik-glonass.ru/> 4. State and prospects of the Russian satellite navigation market in 2010: an analytical review. – M: 2011 http://aggf.ru/analitika/AGGF_2011.pdf
5. Introduction to geoinformation systems / Web-site "GIS-Lab and authors" (<http://gislab.info/docs/giscourse/>), Aug. 2007
6. Basic GIS - RECOD platform. <http://ssc.rekod.ru/content/services/3>

Internet-based sources

1. ELS of RUDN University and third-party ELS, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System - RUDN EBS <http://lib.rudn.ru/MegaPro/Web>
- ELS "University Library Online" <http://www.biblioclub.ru>
- EBS Yurayt <http://www.biblio-online.ru>
- ELS "Student Consultant" www.studentlibrary.ru
- EBS "Lan" <http://e.lanbook.com/>
- EBS "Trinity Bridge"

2. Databases and search engines:

- electronic fund of legal and normative-technical documentation <http://docs.cntd.ru/>
- Yandex search engine [https:// www.yandex.ru/](https://www.yandex.ru/)
- Google search engine <https://www.google.ru/>
- abstract database SCOPUS [http:// www .elsevierscience.ru/ products / scopus /](http://www.elsevierscience.ru/products/scopus/)

8. List of available Indices Index DataBase A database for remote sensing indices. URL: <https://www.indexdatabase.de/db/i.php>

8. MID-TERM ASSESSMENT AND EVALUATION TOOLKIT

Evaluation materials and a point- rating system* for assessing the level of competence formation (part of competences) based on the results of mastering the discipline **Remote Sensing of MSW objects** are presented in the Appendix to this course syllabus.

DEVELOPER:

Associate Professor of the NM
Department

Kapralova D.O.

Position

Signature

Name, Surname

HEAD OF DEPARTMENT:

Director of the NM Department

Kucher D.E.

Position

Signature

Name, Surname

HEAD OF PROGRAMME:

Associate Professor of the
ES&PQM Department

Popkova A.V.

Position

Signature

Name, Surname

APPROVED

Department meeting protocol No _____,

Dated _____

day, month, year

Head of Educational Department

_____(Kucher D.E.)

signature

ASSESSMENT TOOLKIT

for the course

Remote Sensing of MSW objects

course title

05.04.06 "Ecology and nature management"

field of studies / speciality code and title

«Integrated Solid Waste Management» (Network program with L.N. Gumilyov Eurasian National University)

higher education programme profile/specialisation title

master

graduate's qualification (degree)

Passport to Assessment Toolkit for Course Remote Sensing of MSW objects

Field of Studies / Speciality 05.04.06 "Ecology and nature management"

Course: Remote Sensing of MSW objects

Competences (competences in part) under assessment	Course module under assessment	Course topic under assessment	Tools to assess higher education programme mastering level					Points for topic	Points for module	
			Class work				Selfstudies	Exam/Pass- fail assessment		
			Test	External course	Lab work	Lecture	Homework			
GC-7 PC-5	Introduction.	The study of the physical basics for Earth Remote Sensing, the study of types and means for remote sensing. Remote sensing data processing software: a variety of GIS,	1	10	10	1		4	26	38
		QuantumGIS interface, loading raster data, vector layers creation,								
		Openstreetmaps, satellite images, georeferencing.			10		2	12		
		Rationale for the use of remote sensing data for the purposes of waste recycling								

GC-7 PC-5	Basic principles of remote sensing, classification of remote sensing methods	Photointerpretation. photointerpretation signs. Features of recognition of artificial and natural objects. Semi-automatic classification. Multispec	1		15	1		3	20	20
GC-7 PC-5	Methods for solving problems using remote sensing and GIS tools	Remote sensing data processing software. GIS software Diversity	2		15	2		3	22	22
		Types of problems solved with the help of GIS,								
		Spatial analysis of GIS, a method for analyzing hierarchies.								
	RSE methods to solve MSW tasks	Vegetation indices, groups of vegetation indices	1		10	1	5	3	20	20
		Polygons. The main deciphering signs of unauthorized dumps. Methods for determining unauthorized dumps.								
		Geocomarketing20								
Total			5	10	60	5	5	15	100	100

Passport to Assessment Toolkit for Course Remote Sensing of MSW objects

QUESTION CARD No 1

QUESTION 1 Application of remote sensing data for waste management purposes

QUESTION 2 Classification of objects by image contrast

Developer _____ (Kapralova D.O.)
signature

Head of Educational Department _____ (Kucher D.E.)
signature

____ day, month, year

Pass/Fail assessment QUESTIONS

1. Direct deciphering signs.
2. Factors affecting the tone (brightness) of the image.
3. Calculating the size of an object from its shadow.
4. Ways to determine the scale of the image.
5. Types of object shape.
6. Classification of objects by image contrast.
7. The concept of the structure of the image. Structure types.
8. The concept of image texture. Image texture types.
9. Generalization during decryption.
10. Application of remote sensing data for waste management purposes
12. Name the groups of \deciphering features.
13. On the identification of what regularities is the use of indirect signs of interpretation based?
14. What are the objects of landscape mapping?
15. Direct deciphering signs.
16. Calculation of the size of an object by its shadow.
17. Ways to determine the scale of the image.
17. Types of object shape.
19. Classification of objects by image contrast.
20. The concept of image structure. Structure types.
20. The concept of image texture. Image texture types.
- 21) The main technical factors affecting the information content of satellite images are
- 22) Atmospheric windows, what is it
- 23) The spectral channels
- 24) Supervised/unsupervised photointerpretation

Note * Practice case/task inclusion is subject to the teacher's discretion.

The set of exam question cards is complemented by the assessment criteria developed by the teacher and approved at the department meeting.

Assessment criteria:

(in compliance with the legal regulations in force)

Test question examples

- 1) The main technical factors affecting the information content of satellite images are
 - Composition of the atmosphere
 - Used equipment
 - country of satellite origin
 - Orbit type (or flight altitude)
 - Presence of clouds - shooting season
- 2) Atmospheric windows are:
 - parts of the electromagnetic spectrum that are not absorbed by the atmosphere
 - parts of the electromagnetic spectrum that are absorbed by the atmosphere
 - parts of the electromagnetic spectrum that the atmosphere reflects
 - territories of countries over where satellites can shoot
- 3) The spectral channel is:
 - Set of intervals of the electromagnetic spectrum
 - The interval at which the sensor is set to take a picture
 - Full interval of all existing wavelengths of electromagnetic radiation
- 4) Radiometric properties of aerospace images characterize
 - The amount of radio radiation of objects
 - The ability of images to reproduce small details and colors of the scene - Wavelength when shooting
- 5) When using active methods of remote sensing
 - the satellite sends a signal of its own energy source to Earth
 - the satellite registers the reflection of radiation
 - satellite turns on by itself

Laboratory works tasks

- 1) Working with rasters - binding, cropping, assembly, drawing up a 3D model based on, building a profile
- 2) Counting points in polygons, building thematic maps and editing them (graded sign, 2.5d, diagrams)
- 3) OSM, using OpenStreet Services
- 4) Vegetation indices, NDVI calculation
- 5) Determination of changes in time
 - vectorization of NDVI, determination of the difference,
 - sample raster values on the layer with NDVI, plotting based on the values of random points over the years)
- 6) Supervised/unsupervised classification in Multispec
- 7) Semi-automated search for landfills - a combination of work in Multispec and QGIS
- 8) Geoecomarketing

Example of Lab work task

Lab #1: Introduction to the Quantum Interface GIS interface (version 3.22)

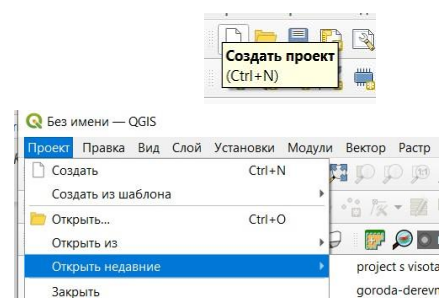
Toolbars and basic menu commands


The purpose of the work : to get an idea about the Quantum software product GIS 3.22. Explore the main features of the program.

Tasks:

1. Launching the program and opening attribute tables.
2. Acquaintance with the main toolbars, menu commands and their purpose.
 - 1) Open the QGIS 3.22 folder, run the program by clicking on QGIS Desktop 3.22.4
 - 2) You can create a new project

or open recent



- 3) The three main toolbars in QGIS contain buttons representing the most commonly used commands, procedures, and tools.
- 4) 
- 5) You can enable additional panels by right-clicking on an empty space in the top panel. Connected panels are visible in the list that appears.

Assessment criteria:

(in compliance with the legal regulations in force)

The assessment of all results of mastering competencies is carried out in accordance with the scale of the international point-rating system ECTS. In accordance with the calculated grading system, the student gains the required points.

Work in class: depends on the complexity of the topic.

The grade is given for attendance and active work at a seminar or lecture (lectures are held in an interactive form) - answers to current questions, notes, discussion. The student is present at the lesson, participates in the discussion, does not hesitate to answer questions - maximum score. The student is absent or the task is not prepared - 0 points.

Lab works – work is done – 5 points, laboratory work is not completed – 0 points.

Tasks of Self-studies: - acquisition of skills of independent practical work in the recommended software and application of various research methods; - developing the ability to independently and critically apply the material being studied. The SR technology should ensure the acquisition of knowledge, the consolidation and systematization of knowledge, the formation of skills and abilities. The proven technology is characterized by an algorithm that includes the following logically related student actions: - reading a text (textbook, manual, lecture notes); - note-taking of the text; - problem solving and exercises; - answers to control questions;

Final certification: A student is considered to have successfully passed the milestone or final certification if the total score for all activities at the time of certification exceeds 50% of the maximum possible score (lecture work, practical assignment, tests).

The final grade for the semester is added up as the sum of points for all types of student activities (*see toolkit passport) and can reach a maximum of 85 points, the article as obligatory for excellent mark.

The final test is given by the student voluntarily, if he scored the minimum possible score for certification - 51 points. In other cases, the test is mandatory and is estimated at a maximum of 10 points, as a result, the total score is derived taking into account the result of passing the test and the final grade corresponds to the international ECTS scale.

Tentative list of assessment tools

п / п	Assessment tool	Brief features	Assessment tool representation in the kit
<i>Class work</i>			
2	Test	A system of standardised tasks that allows the teacher to automate the procedure for measuring the student's level of knowledge and skills	Tests bank
4	Control work	A tool of control organised as a classroom lesson, at which students need to independently demonstrate the acquisition and mastering of the educational material of the course topic, section, or sections.	Questions on the course topics /modules
5	Lab work	The system of practice tasks aimed at the students' practical skills formation	Practice tasks bank
10	Pass/Fail assessment	A tool for checking the quality of students' performance of laboratory work, acquisition and mastering of the practice training and seminar educational material, successful completion of the advanced field internship and pre-graduate internship and fulfillment of all training assignments in the course of these internships in accordance with the approved programme.	Tasks examples
11	Exam	The evaluation of the student's work during the semester (year, the entire period of study, etc.); it is designed to identify the level, soundness and systematic nature of theoretical and practical knowledge gained by the student, formation of independent work skills, development of creative thinking, ability to synthesise the acquired knowledge and apply it to solve practice tasks.	Examples of tasks/questions/exam question cards

14	Multi-level tasks and assignments with varying difficulty	<p>The tasks and assignments differ in terms of the following levels:</p> <p>a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline,</p> <p>b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesise, analyse, generalise factual and theoretical material and formulate specific conclusions, establish cause-and effect relationships,</p> <p>c) creative level allows to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.</p>	Set of multilevel tasks and assignments with varying difficulty
<i>Self- studies</i>			
8	Homework	The tasks and assignments differ in terms of the following levels:	Set of multilevel tasks and assignments with varying difficulty
		<p>a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline,</p> <p>b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesise, analyse, generalise factual and theoretical material and formulate specific conclusions, establish cause-and effect relationships,</p> <p>c) creative level allows the teacher to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.</p>	

Criteria for assessing students' knowledge

Points BRS	Traditional grades in the Russian Federation	Points for transferring grades	Grades	ECTS grades
86 - 100	5	95 – 100	5+	A
		86 – 94	5	B
69 - 85	4	69 – 85	4	C
51 - 68	3	61 - 68	3+	D
		51 - 60	3	E
0 - 50	2	31 - 50	2+	FX
		0 - 30	2	F

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