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

COURSES' DESCRIPTION

The mastering of the course is carried out as part of the implementation of the main professional syllabus (Higher Education programme, specialization)

«Integrated Solid Waste Management»

(Profile/Specialization of Higher Education Professional Program)

implemented in the Higher Education Field:

05.04.06 Ecology and Nature Management

(Code and Name of Higher Education Field)

Disciplines (modules) are studied as part of the mastering of Higher Education Program «Integrated Solid Waste Management » (Joint Program with the Eurasian National University named after L.N. Gumilyov)» in frame of Higher Education Field 05.04.06 Ecology and Nature Management

Course title	<i>IT in ecology and natural resources management</i>
Course Workload, credit units /academic hours	4 /144
Brief Course Content	
Course Modules	Course Modules and Contents:
Actual problems of ecology and nature and the mission of computer technology analysis and processing of information	Computational methods of environmental impact assessment, risk assessment etc. The use of computer tools (Excel) for economic and environmental settlements. Specialized programs for complex calculations to assess the impact on the environment and risk analysis. The software graphics processing means. Software GIS tools.
Primary processing of statistical data with Excel	Characteristics of distribution, their interpretation and the ways of their calculation on the sample. Compilation series interval and calculation of their characteristics. Histogram and polygon feature of frequency allocations.
Testing statistical hypotheses	<p>Statistical hypothesis and their application to realworld problems.</p> <p>Parametric tests and conditions of use. Testing the hypothesis of distribution law.</p> <p>Comparison of the average value and of the variances of two samples using parametric tests.</p> <p>Nonparametric tests. Calculation agreed ranks.</p> <p>Comparison of the average value and of the variances of two samples using nonparametric tests.</p> <p>Comparison of the average by more than two samples. Variance analysis. Nonparametric variance analysis.</p> <p>Assessment of data consistency.</p> <p>Errors of observation and confidence intervals characteristics of large and small samples.</p> <p>Determining the nesessery sample size.</p>
Correlation and regression analysis	<p>Statistical connection and methods of research.</p> <p>Correlation coefficient: graphical evaluation, Pearson's coefficient, Spearmen'sc coefficient? Kendall's coefficient.</p> <p>Linear regression analysis. Simple linear regression.</p> <p>Multiple linear regression.</p> <p>Nonlinear regression models, correlation ratio.</p>
Analysis of time series	<p>Time series, classification, structure, tasks and conditions of the study.</p> <p>Characteristic's analysis of the time series.</p> <p>Analysis of the dynamic series trend. Forecasting.</p> <p>Identification of seasonal fluctuations in the dynamic series.</p>

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Course title	<i>International cooperation in the field of nature protection</i>
Course Workload, credit units /academic hours	4/144
Brief Course Content	
Course Modules	Course Modules and Contents:
Introduction. The concept of international cooperation in the field of environmental protection, the main stages of its formatio	The subject, objects, principles and sources of international legal regulation of environmental quality.
Modern global environmental problems and the implementation of the principles of sustainable environmental and economic development.	Sustainable Development Goals. Criteria for sustainable development. The concept of a circular economy. International experience in jointly solving global international organizations and their role in environmental protection of environmental problems
International conferences as a tool for solving international environmental problems.	The role of the international treaty and its features in the regulation of interstate relations in the field of environmental protection. International agreements. Contribution of international conferences to the development of international environmental law (retrospective analysis). Basic international legal documents. The content of the most important regional agreements.
Legal mechanisms of international legal regulation	General concepts of international environmental law. International legal regulation of the protection of the marine environment; protection of atmospheric air, near-Earth outer space and climate. International legal protection of biological diversity in general, flora and fauna. State Responsibility for Environmental Pollution

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Course title	<i>Methodology of Scientific Creation</i>
Course Workload, credit units /academic hours	4/144
Brief Course Content	
Course Modules	Содержание раздела (тем) дисциплины:
Module 1. Scientific research methods, their development in ecology	Topic 1.1. Basic terms and definitions, structure of research activities, relevance and scientific novelty, classification of scientific research methods, Topic 1.2. Tools for identifying problems, methods aimed at enhancing the use of experience and intuition of specialists, logical laws
Module 2. Introduction to Information Retrieval Theory	Topic 2.1. Information, types of information, ascending/descending information flows, the birth of information, the law of information dispersion Topic 2.2. Search for information, search for information in the Internet, use of libraries and databases
Module 3. Empirical methods of knowledge	Topic 3.1. Methods of empirical knowledge, observation Topic 3.2. Measurements, measurement scales, measurement errors Topic 3.3. The concept of an experiment, experiment planning, processing of experimental results Topic 3.4 Surveys, interviews, expert surveys
Module 4 Methods and approaches to the analysis of the obtained data	Topic 4.1 Statistical and mathematical methods in ecology. Reliability and validity of the obtained data. Topic 4.2. Experiment, approaches to analysis. Collection and analysis of databases
Module 5 Presentation of scientific data	Topic 5.1 General requirements for research work, the basics of scientific citation, the effectiveness of scientific research Topic 5.2 The concept of plagiarism in scientific activity Topic 5.3 Discoveries, their mechanism and typology
Module 6 Final qualifying works	Topic 6.1 Thesis planning. Responsibilities of the head of the thesis. Structure and design of the thesis Topic 6.2 Approaches to presenting thesis data Topic 6.3 Presentation of the work
Module 7 Research Article	Topic 7.1 Types of scientific articles. Types and ratings of journals. Topic 7.2 Citation index Topic 7.3 Article writing approaches
Module 8 Conferences, symposiums, etc	Topic 8.1 Types of scientific events. Purposes of participation in conferences, etc. Presentation of materials. Scientific discussion and its importance in promoting research, conducting scientific discussion
Module 9 Financial support for research	Topic 9.1 Grants. Funds. Paid scientific activity within the framework of contracts. Grant application, execution and planning.

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Module 10 Ethical aspects of scientific research in ecology	Topic 10.1 Ethical code of the ecologist. Rules of biological ethics in scientific research.
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Course title	<i>Foreign (Russian) Language</i>
Course Workload, credit units /academic hours	6/216
Brief Course Content	
Course Modules	Содержание раздела (тем) дисциплины:
Section No. 1. Introductory phonetics and grammar course	Topic 1.1. Pronunciation and spelling
Section No. 2. A basic level of	Topic 2.1. Gender of nouns. Possessive pronouns.
	Topic 2.2. Expressing time in a simple sentence)
	Topic 2.3. The concept of the Russian verb. Instrumental case of nouns.
	Topic 2.4 Instrumental case of nouns. Verb WANT .
	Topic 2.5. A model for the formation of the past tense from verbs with constant stress based on
	Topic 2.6. A model for the formation of the past tense from verbs with variable stress.
	Topic 2.7. Constructions <i>need + infinitive, can + infinitive, What is needed (can) + infinitive</i>
	Topic 2.8. Complex future tense of verbs.
	Topic 2.9. The verb <i>to study</i> is in the present, past and future tenses.
	Topic 2.10. The verb <i>to speak</i> is in the present, past and future tenses. Imperative.
	Topic 2.11. The verb <i>to teach</i> is in the present, past and future tenses.
	Topic 2.12. Expressing the absence of a subject (<i>he does not exist</i>). Telephone etiquette.
	Topic 2.13. Constructions <i>I have (was, will be)</i> and <i>I don't have (didn't have, won't)</i> .
	Topic 2.14. <i>I like</i> the design . Comparison of typical contexts of use of the verbs <i>love</i> and <i>like</i> .
	Topic 2.15. Prepositional case of place.
	Topic 2.16. Expressing time in a simple sentence. Prepositional case verbs.
	Topic 2.17. Telephone etiquette. Formation of simple comparative degree of adverbs
	Topic 2.18. The instrumental case in the meaning of compatibility of action
	Topic 2.19. General idea of verbs of motion. Accusative case to indicate direction of movement.
	Topic 2.20. The verbs of the group <i>go</i> and <i>walk</i> in the future and past tenses.
	Topic 2.21. Ordinals. Constructions of time.
	Topic 2.22. Genitive case to indicate direction (with the question <i>from where?</i>) .
	Topic 2.23. Verbs of motion <i>go, go, go, go, come, arrive, walk, ride</i> .
	Topic 2.24. Verb <i>to return</i> . Features of conjugating verbs with the particle – <i>xia</i> . .
	Topic 2.25. Telephone etiquette. Formation and use of imperative forms with the word <i>let</i> .

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Course title	<i>Nature Protection and Accumulated Environmental Damage (AED) Elimination Tools</i>
Course Workload, credit units /academic hours	4/144
Brief Course Content	
Course Modules	Course Modules and Contents:
Introduction	The main sources of accumulated environmental damage and the features of its impact on the environment. Foreign experience in the elimination of objects of accumulated harm to the environment The scale of accumulated harm and the experience of land rehabilitation in Europe and the USA.
Classification of AED objects	Approaches to the classification of objects of accumulated environmental damage. Assignment criteria Classification of technological solutions (methods) for the rehabilitation of objects of accumulated harm. Classification of disturbed lands according to technogenic relief and area. Types of natural technogenic landscapes.
Stages of restoration natural-technogenic landscapes. Examples of the most dangerous objects.	Stages of restoration of natural and technogenic landscapes Formation of vegetation cover on dumps and artificial reservoirs Requirements for the reclamation of lands disturbed during the construction and operation of linear structures Peculiarities of Rehabilitation of Certain Objects of Accumulated Damage to the Environment AED and Specific Territories Restoration of water bodies Features of reclamation of MSW landfills as objects of accumulated harm

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Course title	<i>Modern Technologies for Nature Protection / Современные технологии защиты ОС</i>
Course Workload, credit units /academic hours	2/72
Brief Course Content	
Course Modules	Содержание раздела (тем) дисциплины:
1. Waste problem. Waste in the environment and ecosystem stability	Concept of waste Stability and safety of the environment Stability and resistance of ecosystems to pollution.
	Ecosystem sustainability concept. The cycle of matter is an important principle of sustainable ecosystems. Biogeochemical cycles of carbon, hydrogen, oxygen, sulfur, phosphorus and metals.
	Self-cleaning capacity of an ecosystem: biotic and abiotic processes. Parameters of ecosystem stability.
2. Wastewater treatment technologies	Sources and types of hydrosphere pollution. Types of wastewater Types of industrial wastewater pollution.
	Modern methods of wastewater treatment from industrial pollution.
	Agricultural and domestic wastewater and treatment methods. Sewage sludge and methods of treatment and disposal.
	Biological methods. Methane fermentation. Composting. Thermal methods.
3. Technologies for cleaning gas emissions.	Classification of gas emissions by state of aggregation Dispersity of systems (particle sizes). Solid particles - aerosols: dust and vapors. Air protection methods. .Methods for cleaning gas and dust emissions from aerosols. Dry and wet methods.
4. Solid waste management:	Sources of solid industrial waste. Methods for neutralization and processing of industrial non-radioactive waste. Warehousing. Heat treatment Sludge processing (plating, oil). Features of recycling by industry. Sources and treatment of hazardous waste
	Features of hazardous waste. Technology for processing household waste. Combustion of solid waste. Energy generation. Ecological aspects of combustion.
	Biothermal aerobic composting technology. Technology of anaerobic digestion and biogas production.
5. Biothermal aerobic composting technology. Anaerobic digestion and biogas production technology	Temporary storage. Storage of hazardous industrial waste. Landfills. Hygienic requirements for the selection of territory and location.
	Layout and arrangement of landfills Ensuring safety control. Features of the discharge of water-soluble liquid and combustible waste. How to choose a location for a landfill? General stages and installation of landfills.
	Modern cleaning chemical mechanical and thermal cleaning Industrial composting
6. Technologies for rehabilitation of water bodies	Types of reservoirs. Types of water pollutants. Sources of water pollution. Water recovery methods. Stages of environmental rehabilitation of water bodies and preparatory work: technical, biological.

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Creation (restoration) of a coastal ecosystem. Comprehensive landscaping of the surrounding area. Examples. Cleaning water bodies from oil products. Reducing the concentration of pollutants in water bodies

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Course title	<i>ОВОС объектов в сфере управления отходами /Environmental impact assessment (EIA) of SWM objects</i>
Course Workload, credit units /academic hours	2/72
Brief Course Content	
Course Modules	Содержание раздела (тем) дисциплины:
Introduction	Basic concepts of environmental impact assessment - project documentation at various stages of the project cycle - practice by country
Strategic environmental assessment – place in environmental impact assessment	Strategic environmental assessment (SEA) as the first stage of assessing the environmental impact of a project
Assessment of the current state of the environment	Methodology and sequence of work on EIA. Preliminary desk stage. Field stage.
	Socio-economic research. The final desk stage.
Involvement of contractors at various stages of EIA - features	Aspects of attracting contractors to conduct EIA at various stages – modern practice.
Legal requirements for EIA - national and international requirements - differences and similarities	Requirements of international legislation for EIA - EU directives, IFC requirements, national acts
Composition of an environmental impact assessment report for facilities in the field of waste management	Composition of the list of environmental protection measures - modern practice of preparing project documentation for facilities in the field of waste management
EIA и ESHIA – similarities and differences	Environmental impact assessment and Environmental social health impact assessment – requirements in different countries - similarities and differences
Monitoring and environmental control - requirements in different countries	Monitoring and environmental control - monitoring program. Main aspects
Issues of calculating damage to environmental components	Issues of calculating damage to environmental components - aquatic and biological resources, plant resources, fauna..
	Red Data Book species
Section 10 Informing the public about the project	Public discussions of project documentation - modern practice of informing the public and holding public discussions in different countries
Practice of calculating fees for negative environmental impact in different countries	Practice of calculating fees for negative environmental impact in different countries
Examination and approval of project documentation for EIA	Examination and approval of EIA materials in different countries
Features of preparing an EIA report - the use of information technology	Practice of using information technology for preparing an EIA

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Course title		<i>Regional & Municipal MSW Management Systems</i>
Course Workload, credit units /academic hours		3/108
<i>Brief Course Content</i>		
№ п/п	Course Modules	Содержание раздела (темы)
1.	1. WORLD EXPERIENCE IN THE WASTE MANAGEMENT. POSSIBLE SCENARIOS	Indicators of sustainable development in the field of waste management. Basic principles of waste management. World trends in the field of waste management. Experience of developed countries The main methods of integrated waste processing in the world.
2.	2. WASTE AS A SOURCE OF SECONDARY RESOURCES AND ENERGY	Goals and objectives of regional waste management programs, indicators of program implementation used, results of implementation. Short and long term programs. Regional features to be taken into account when developing programs. Waste composition. Analysis of the resource and energy potential of waste
3.	3. MECHANISMS FOR WASTE MANAGEMENT IMPROVING (CASE OF STUDY - RUSSIAN FEDERATION).	Improving the regulatory framework in the field of waste management. Environmental fee and extended liability of producers and importers of goods. Tariffs for waste removal and disposal
4	4. BASICS OF THE WASTE MANAGEMENT SYSTEM AT THE STATE, REGIONAL, CITY LEVEL	Levels of hierarchy in the field of waste management. Minimizing waste generation – resource-saving and low-waste technologies. Classification of solid waste and organization of a separate collection system. Distribution of cash flows. Extended producer responsibility. Environmental fee
5	5. REGIONAL AND MUNICIPAL SCHEMES IN THE WASTE MANAGEMENT SYSTEM	Territorial waste management schemes. Institute of Regional Operators. Determination of waste streams generated in various industries and municipal services. Directions of the waste management strategy: creating conditions to reduce the amount of waste; ensuring growth in the volume of waste use; creation of environmentally safe conditions for waste storage and disposal.
6	6. COMPLEX SCHEMES FOR TREATMENT AND DISPOSAL OF MSW	A set of waste processing methods focused on regional and sectoral application. Use of integrated recycling, composting and waste incineration. Flexibility of the waste management structure. Waste monitoring and control systems. Increasing the technical level of waste processing, creation and implementation of low-waste technologies. Best available technologies in waste management

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Course title	<i>Regional & Municipal MSW Management Systems</i>
Course Workload, credit units /academic hours	3/108
<i>Brief Course Content</i>	
Course Modules	Содержание раздела (темы)
1. INTRODUCTION: WASTE MANAGEMENT ISSUES AND SOLUTIONS	Topic 1.1. Sources of waste generation and impact on the environment. Modern approaches to waste management. Waste in circular economy. Concepts and basic principles of resource saving. Products from Waste: Problems and Solutions. Waste processing industry. materials. Technology for the production of secondary raw materials.
	Topic 1.2. Technologies for municipal solid waste processing. General characteristics of technologies. The main types of waste, their brief description, principles of classification and subsequent processing. Basic concepts of waste management. Warehousing and landfilling of MSW.
Section 2 NON-ORGANIC WASTE: PROCESSING.	Topic 2.1. Mechanical processing of solid waste. Methods for the preparation and processing of solid waste. Goals of waste processing. Waste shredding: crushing and grinding, milling. Crushing stages, basic regularities. Large medium and fine crushing. Grinding of hard materials. Fine and ultra-fine grinding. Grinding schemes. Mill types. Classification of materials and equipment for its implementation.
	Topic 2.2 Separation technics and equipment. Principles of classification. Hydraulic and air classification and equipment for implementation. Aeroseparation. Vibroseparation. Hydroseparation. Dosing of bulk materials. Feeders. Dosers. Mixing solids. Screening. Types of screens, grids and sieves
Section 3 ORGANIC WASTE: HANDLING.	Topic 3.1. Thermal processing of waste. Obtaining granulated fuel (RDF). Waste pyrolysis. Oxidative pyrolysis followed by combustion of pyrolysis gases; dry pyrolysis. Waste gasification. Fire method of waste processing. Incineration of solid combustible waste. Classification of combustion methods. Equipment for fire neutralization and waste processing.
	Topic 3.2 Microbiological decomposition of bioorganic waste. Composting (stages, technics and equipment, parameters, products). Methane digestion (stages, conditions, products). compaction, stabilization, conditioning, dewatering, decontamination and decontamination
	Topic 3.3. Sewage sludge. Formation of sewage sludge. Characteristics of sediments (humidity, density, fluidity and contamination. Sludge Treatment Processes: Compaction, Stabilization, Conditioning, Dewatering, Decontamination and Neutralization.

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Course title	<i>Management of Environmental-economic Risks / Управление эколого-экономическими рисками</i>
Course Workload, credit units /academic hours	3/108
<i>Brief Course Content</i>	
Course Modules	Содержание раздела (темы)
Introduction	The concept of environmental risks. Enterprise risks and their assessment
	Project risks, their minimization and the need to take into account when analyzing the sustainability of investment projects
Risk analysis and assessment	Environmental and economic risks and methods of their analysis and assessment
	Risk identification. Risk factors
	Economic characteristics of environmental risks
Environmental risk and environmental projects	Risks of environmental and industrial safety in investment projects
	Climate risks.
Risk management in environmental management	Management of risks. Environmental insurance
	Minimizing environmental risks for sustainable operation of enterprises
Minimizing environmental risks	Minimizing environmental risks and implementing environmental management systems

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Course title	Software Tools for Waste Management / Программное обеспечение для управления отходами
Course Workload, credit units /academic hours	3/108
Brief Course Content	
Course Modules	Course Modules and Contents:
Module 1. Processing and presentation of measurement results	Excel
	Cluster analysis
Module 2. Environmental assessment	Tools for calculating dispersion, NDV (MPV), NMU, inventory (Integral)
	Greenhouse Gas Analysis Tools IPCC Waste Model, Landgem
Module 3. Modeling	Mathematical models (Vensim)
	Lcycle assessment
	Energy efficient houses

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Course title	Environmental Control and MSW Monitoring Programs / Методы контроля и мониторинга в системе управления отходами
Course Workload, credit units /academic hours	5/180
Brief Course Content	
Course Modules	Course Modules and Contents:
Section 1. Waste management system. Classification of types of ecological monitoring.	Waste management system. Classification of types of ecological monitoring. Monitoring the quality of air, water, soil, waste, enterprises. Environmental Monitoring Program.
Section 2. Classification of physical and chemical methods of control and monitoring in the waste management system	Classification of physical and chemical methods of identification and quantitative determination of organic and inorganic substances of various genesis. Chemical methods. Physical methods. Physical and chemical methods. biological methods. The main directions of application of each group of methods.
Section 3. Methods of elemental analysis	Atomic adsorption analysis. Atomic emission analysis. X-ray fluorescence analysis. Neutron activation analysis. Method of mass-spectral analysis.
Section 4. Chromatography	Chromatographic separation of a mixture of substances. Physical and chemical adsorption. adsorption-desorption equilibrium. Width and shape of the chromatographic peak. Resolution of the chromatographic column. The device and scheme of operation of the chromatograph. Dead time and retention time. Packed and capillary columns, their parameters. Optimal dimensions and resolution of the chromatographic column. Detectors.
Section 5. Mass Spectrometry	Ionization methods: electron impact, chemical ionization, photoionization, field ionization, field desorption, fast atom bombardment, matrix laser desorption ionization (MALDI), electrospray. Ion detectors: Faraday cup, secondary electron multiplier, multichannel amplifier. Mass analyzers: operating principles, resolution. Advantages and disadvantages. Analytical possibilities of mass spectrometry. Molecular, fragmentation and metastable ions. Combinations of a mass spectrometer with chromatographs. Examples of the use of mass spectrometry.

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Section 6. Optical spectroscopy	Classes of spectral devices. Dispersive elements of spectral instruments and their resolution. The passage of light through an absorbing medium. Absorption cross section, molar extinction coefficient. Law of Lambert-Bouguer-Beer. Spectra of absorption, emission and scattering. Luminescence and fluorescence. Spectral ranges and corresponding degrees of freedom in molecular systems. Rotational spectra and microwave spectroscopy. Vibrational spectra and infrared spectroscopy. Vibrations of polyatomic molecules. Electronic transitions and spectroscopy in the visible and ultraviolet ranges. Intensity of electronic-vibrational spectra: Franck-Condon principle. Spectroscopy of Raman scattering of light.
Section 7. Radiospectroscopy	Magnetic moments of the electron and nuclei. NMR active nuclei. Spin in a constant magnetic field. Magnetic moment and Larmor precession. Absorption of energy of a high-frequency field. Spectroscopy of nuclear magnetic resonance. Chemical shift. Spin-spin interaction. Application of the NMR method. Spectroscopy of electron paramagnetic resonance. Hyperfine structure of the EPR spectrum. Structural and dynamic characteristics of a substance determined by EPR methods. Schematic diagram of an EPR spectrometer. Application of the EPR method.
Section 8. Federal Law on production and consumption waste	Basic concepts. Legal regulation in the field of waste management. Requirements for waste disposal facilities. Requirements for the handling of hazardous waste. Requirements for the transport of hazardous waste. State cadastre of waste. Production control in the field of waste management.

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Course title	Physicochemical Methods of Waste Testing / Физико-химические методы контроля компонентов отходов
Course Workload, credit units /academic hours	5/180
Brief Course Content	
Course Modules	Course Modules and Contents:
Section 1. Classification of methods for monitoring and identifying of waste components	Chemical methods. Physical methods. Biological methods. The main fields of application of each group of methods.
Section 2. Methods of elemental analysis	Atomic adsorption analysis. Atomic emission analysis. X-ray fluorescence analysis. Neutron activation analysis. Method of mass-spectral analysis.
Section 3. Titrimetric methods of analysis	Types of titrimetric analysis. Titration types.
Section 4. Mass Spectrometry	Ionization methods: electron impact, chemical ionization, photoionization, field ionization, field desorption, fast atom bombardment, matrix laser desorption ionization (MALDI), electrospray. Ion detectors: Faraday cup, secondary electron multiplier, multichannel amplifier. Mass analyzers: operating principles, resolution. Advantages and disadvantages. Analytical possibilities of mass spectrometry. Molecular, fragmentation and metastable ions. Combinations of a mass spectrometer with chromatographs. Examples of the use of mass spectrometry.
Section 5. Chromatography	Chromatographic separation of a mixture of substances. Physical and chemical adsorption. adsorption-desorption equilibrium. Width and shape of the chromatographic peak. Resolution of the chromatographic column. The device and scheme of operation of the chromatograph. Dead time and retention time. Packed and capillary columns, their parameters. Optimal dimensions and resolution of the chromatographic column. Detectors.
Section 6. Radiospectroscopy	Magnetic moments of the electron and nuclei. NMR active nuclei. Spin in a constant magnetic field. Magnetic moment and Larmor precession. Absorption of energy of a high-frequency field. Spectroscopy of nuclear magnetic resonance. Chemical shift. Spin-spin interaction. Application of the NMR method. Spectroscopy of electron paramagnetic resonance. Hyperfine structure of the EPR spectrum. Structural and dynamic characteristics of a substance determined by EPR methods. Schematic diagram of an EPR spectrometer. Application of the EPR method.

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<p>Section 7. Optical spectroscopy</p>	<p>Classes of spectral devices. Dispersive elements of spectral instruments and their resolution. The passage of light through an absorbing medium. Absorption cross section, molar extinction coefficient. Law of LambertBouguer-Beer. Spectra of absorption, emission and scattering. Luminescence and fluorescence. Spectral ranges and corresponding degrees of freedom in molecular systems. Rotational spectra and microwave spectroscopy. Vibrational spectra and infrared spectroscopy. Vibrations of polyatomic molecules. Electronic transitions and spectroscopy in the visible and ultraviolet ranges. Intensity of electronic-vibrational spectra: Franck-Condon principle. Spectroscopy of Raman scattering of light.</p>
<p>Section 8. Federal Law on production and consumption waste</p>	<p>Basic concepts. Legal regulation in the field of waste management. Requirements for waste disposal facilities. Requirements for the handling of hazardous waste. Requirements for the transport of hazardous waste. State cadastre of waste. Production control in the field of waste management.</p>

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Course title	Mapping And GIS-technologies in MSW Management / Методы картографирования и ГИС-технологии в управлении ТКО
Course Workload, credit units /academic hours	4/144
Brief Course Content	
Course Modules	Course Modules and Contents:
Introduction.	Geoinformatics as a science. What is GIS. GIS classification. QuantumGIS interface, loading raster data, creating vector layers. Raster operations. Vector operations. Openstreetmaps, satellite images, georeferencing
Basic principles of remote sensing and photointerpretation	Photointerpretation. Features of recognition of artificial and natural objects
Spectral indices	Data analysis using QGIS: variety of indices, their meaning and practical application, NDVI calculation, introduction to the QGIS raster calculator. Landscape indices. Building index
Possibility of using remote sensing for waste management facilities	Decision support. Simulation of various situations. Solving forecasting problems. Introduction of GIS for waste management into the city GIS Examples of creating a GIS for MSW management for specific regions/municipalities

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Course title	Remote Sensing of MSW Objects / Методы ДЗЗ и обработки информации объектов управления ТКО
Course Workload, credit units /academic hours	4/144
Brief Course Content	
Course Modules	Course Modules and Contents:
Introduction.	Study of the physical foundations of remote sensing of the Earth, study of types and means of remote sensing of the Earth.
	Software for processing remote sensing data: types of
	QuantumGIS interface, loading raster data, creating vector layers Satellite Imagery
	Types of Satellites and Missions, Open Image Sources
Basic principles of Earth remote sensing, classification of Earth remote sensing methods.	Decoding. Features of recognition of artificial and natural objects
	Semi-automatic classification
Methods for solving problems using remote sensing and GIS tools	Spatial GIS analysis, hierarchy analysis method. Cluster analysis, Geoecomarketing Vegetation indices, groups of vegetation indices. Landscape indices. Landfills. The main decipherable signs of unauthorized landfills. Methods for identifying unauthorized dumps. Web GIS, Google Earth Engine.
	Spatial GIS analysis, hierarchy analysis method. Cluster analysis, Geoecomarketing
	Vegetation indices, groups of vegetation indices.
	The main decipherable signs of unauthorized landfills. Methods for identifying unauthorized dumps.
	Web GIS, Google Earth Engine.

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Course title	Basics of Circular Economics / Основы циркулярной экономики
Course Workload, credit units /academic hours	3/108
Brief Course Content	
Course Modules	Course Modules and Contents:
Circular economy: conceptual basics	Economic content of green economy and sustainable development. Definition of green economy and sustainable development.
	Functions, goals and objectives of the green economy. The concept and current trends in the development of the circular economy. Principles and tools of the "green economy" and its contribution to the transition to sustainable development.
Economic mechanisms for environmental protection	Indicators of sustainable development. OECD indicator systems. UNCSD indicator systems. Economic levers of implementation.
	Payment for negative impact on the environment. Environmental fee and manufacturer's responsibility. Environmental entrepreneurship. Ecological insurance.
	State support for economic and (or) other activities carried out for the purpose of environmental protection. Basic legal documents regulating environmental principles.
The economic value of nature and the nature management efficiency	The need to determine the economic value of nature. National wealth and its composition. Indicators of national wealth (method of the World Bank).
	Accounting for the environmental factor in the main indicators of economic development.
	Implementation of the principles of green development: "polluter pays (PP)" and implementation of policy 3 R . The concept of consumer surplus.
Towards circular economy: conditions and opportunities for the transformation of the technogenic type of economic development	The need for a transition to a sustainable type of development and the introduction of elements of a "green" economy.
	Limitations of technogenic development: environmental (degradation and depletion of natural resources, pollution and waste), economic (investment), social (ill health, environmental migrants).
	Alternative options for solving environmental problems; development of low-waste and resourcesaving technologies; technological changes; direct environmental protection measures.
	Reducing the share of natural resource industries and increasing the share of knowledge-intensive high-tech industries
Legislation in the field of environmental protection and the concept of “best available technology (BAT)”	Mechanisms for the implementation of environmental and economic policy: direct regulation (state influence), economic incentives (market mechanisms), mixed mechanisms. Formation of environmental legislation.
	The role of the state in the formation of a circular economy.

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Course title	Green Economy and Tools for Enterprises Sustainable Development / Зеленая экономика и инструменты устойчивого развития предприятий
Course Workload, credit units /academic hours	3/108
Brief Course Content	
Course Modules	Course Modules and Contents:
Module 1. Fundamentals of a green economy	Topic 1.1. The concept and essence of the "green" economy. The international context for the formation of a "green" economy.
	Topic 1.2. The concept of the circular economy: its origins and evolution. Industrial ecology. The concept of "From cradle to cradle". Circular economy. Blue economy. Biomimicry .
Module 2 Transition from a linear economy to a circular economy	Topic 2.1. Limits of development of linear economy. Barriers and drivers of development circular economy. Environmental, resource, economic and social benefits of a circular economy.
	Topic 2.2. Basic principles and mechanisms of the circular economy. Possibilities of material recycling. Types of cycles within the green economy. Ways to preserve the value of products. New cyclical business models.
	Topic 2.3. Fundamentals of green growth. Methodological approaches to assessing the potential of green growth of territories and regions.
Module 3 Economic Valuation of Ecosystem Services	Topic 3.1. Types of capital involved in the green economy. The concept of ecosystem services. Classification of ecosystem services.
	Topic 3.2. The use of remote sensing technologies in the valuation of ecosystem services
	Topic 3.3. An overview of approaches to the economic valuation of ecosystem services.
Module 4 Product life cycle assessment as one of the tools of the circular economy	Topic 4.1. Using the Product Life Cycle Assessment (LCA) Toolkit to Create a Circular Economy. production system. single processes. OZHCP: basic concepts, stages.
	Topic 4.2. Application of life cycle assessment to industrial symbioses.
Module 5 Enterprise sustainability	Topic 5.1. Definitions of sustainable development of enterprises. Components of sustainable development of enterprises: economic sustainability, social responsibility, environmental performance

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	<p>Topic 5.2. Corporate Social Responsibility and Environmental Efficiency The concept of corporate social responsibility (CSR). Evolution of views on the role of business in society. CSR principles. Elements of CSR. Models and standards of CSR. Evaluation of the social efficiency of enterprises. Non-financial reporting of the enterprise. Evaluation of the environmental efficiency of the enterprise. ISO 14031</p>
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Course title	Engineering Ecology / Инженерная экология
Course Workload, credit units /academic hours	3/108
Brief Course Content	
Course Modules	Course Modules and Contents:
Anthropogenic processes as a factor of environmental pollution.	Modern anthropogenic activities and environmental pollution factors. OS components: atmosphere, hydrosphere, pedosphere. Features of the distribution of ecotoxins in abiotic and biotic components
Self-cleaning ability of ecosystems. Parameters of ecosystem sustainability	Principles of the existence of ecosystems. Homeost Resistance of ecosystems to pollution. Cycle of substances and elements. Soil microbiocenosis and soil functions.
	The ability of ecosystems to self-purify. Abiotic processes of self-purification. Biotic processes of self-purification.
	Microbiocenoses of water bodies. Microflora air. Degree and speed of self-cleaning. Assimilative capacity of the ecosystem
Sources and types of hydrosphere pollution. Wastewater	Main sources of wastewater generation. Classification and composition of wastewater. Kinds sewage pollution
	Modern methods of wastewater treatment. Technological cleaning schemes. Organization closed water production cycles.
Sources and types of atmospheric pollution. Gas air emissions.	Sources and types of air pollution. Classification and composition of gas-air emissions.
	Principles of atmospheric air protection. Modern methods of cleaning gas-air emissions and protecting atmospheric air.
Sources and types of pedosphere pollution. Solid waste	Sources and types of pedosphere pollution. Solid waste concept. Sources of generation and classification of waste. Hazardous waste
	Fundamentals of sustainable waste management. Energy and material potential of waste. Principles of the circular economy.
	Sources of formation of solid industrial waste. Municipal solid waste. Environmental features of hazardous waste.
Modern methods of solid waste and sewage sludge management	Basic methods of liquidation and processing of industrial non-radioactive waste. Disposal in landfills and landfills. Heat treatment.
	Basic methods of processing and disposal of municipal solid waste. Sorting and use as secondary raw materials.
Accumulated harm to the environment (AED). AED objects and their remediation (restoration)	Classification of NVOS objects. Stages and methods of environmental rehabilitation of objects NVOS: technical, biological.
	Remediation of soils and closed landfills. Cleaning soils and grounds from ecotoxins (petroleum products, heavy metals). Biological recovery methods reservoirs. Cleaning water bodies from petroleum products, heavy metals

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Course title	Monitoring of Environmental Impacts / Мониторинг воздействия на окружающую среду
Course Workload, credit units /academic hours	3/108
Brief Course Content	
Course Modules	Course Modules and Contents:
Introduction.	The impact of enterprises on the environment: classifications and indicator substances. The subject and object of industrial environmental monitoring (IEM). Main tasks.
PEM in the structure of the environmental monitoring system.	ESSM, departmental environmental monitoring of IEM in the structure of the environmental monitoring system. ESSM, departmental environmental monitoring. Legislative and regulatory-technical base of the organization of IEM
Instruments and systems for monitoring the atmosphere and air of the working area	Instruments and systems for monitoring the atmosphere and air of the working area. Regulatory support for monitoring. The main types of devices. Approaches to the organization of monitoring of the atmosphere in production conditions. GIS technologies and remote methods. Use of IEM data of the state of the atmosphere
Instruments and systems for monitoring the quality of water bodies.	Devices and systems for monitoring the quality of water bodies. Regulatory support for monitoring. Surface water monitoring system. Monitoring of groundwater. Geodynamic monitoring. GIS technologies and remote methods
Soil quality monitoring devices and systems	Soil quality monitoring devices and systems. Regulatory support for monitoring. Methods of selection and indicators of soil and soil quality. GIS technologies and remote methods
Devices and systems for monitoring the quality of biological resources	Devices and systems for monitoring the quality of biological resources. Regulatory support for monitoring. Monitoring of the state of biological objects. Bioindication. GIS technologies and remote methods