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

Institute of Environmental Engineering

COURSE SYLLABUS

MSW Recycling and Utilization Technics

**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 program
of higher education:**

«Integrated Solid Waste Management»

1. 1. COURSE GOAL(s)

The discipline "Recycling and Disposal Technologies for Municipal Solid Waste (MSW)" is part of the Master's program "Integrated Municipal Solid Waste Management" in the field of study 05.04.06 "Ecology and Environmental Management" and is studied in the 3rd semester of the 2nd year. The discipline is delivered by the Department of Environmental Safety and Product Quality Management. The discipline consists of 3 sections and 7 topics and is aimed at studying the sources of waste generation and their composition, the main types of waste with their brief characteristics, principles of classification and subsequent processing. It examines methods of mechanical processing and sorting, thermal utilization, including direct (layer) incineration, various types of pyrolysis, gasification, and the specific features of incinerating solid and liquid combustible wastes. Separate attention is given to methods of treatment and disposal of sewage sludge, depending on moisture content, density, fluidity, and contamination, as well as sludge preparation processes: thickening, stabilization, conditioning, dewatering, sanitization, and detoxification.

The aim of the discipline is to develop knowledge, skills, and competencies in the field of treatment and disposal of hazardous and municipal waste:

- Knowledge of technological solutions applied for the treatment and disposal of solid waste;
- Skills in correctly classifying waste, selecting methods of treatment, sorting, and disposal;
- Competencies in developing process flow diagrams for the preparation and disposal of waste of different hazard classes, selecting the Best Available Technology (BAT) for waste disposal, and calculating the costs of technology implementation.

2. REQUIREMENTS FOR COURSE OUTCOMES

Mastering the discipline " MSW Recycling and Utilization Technics " is aimed at developing the following competencies (parts of competencies) among students:

Table 2.1. The list of competencies formed by students in the course of mastering the discipline (the results of mastering the discipline)

Cipher	Competence	Competence achievement indicators (within this discipline)
GPC-1	Capable of employing philosophical concepts and the methodology of scientific cognition in the study of different levels of organization of matter, space, and time.	GC-1.1. Possesses knowledge of the interrelationship between the intuitive, unconscious, and conscious dimensions of scientific creativity; the social and psychological drivers of scientific creativity; the issues surrounding the moral assessment of scientific creativity; bioethics; and the integrative trends in contemporary epistemology;

		GC-1.2 Performs methodological substantiation of scientific research;
		GC-1.4. Has mastery of skills in historical-methodological analysis of scientific research and its outcomes; all forms of scholarly communication; techniques for conducting discussions and polemics; skills in public speaking and written argumentative presentation of one's own viewpoint.
GPC-2	Capable of utilizing specialized and novel areas of ecology, geoecology, and nature management in addressing scientific-research and applied problems within professional practice.	GPC-2.1. Knowledge of the basics of environmental regulation and the fundamentals of legislation in the field of nature management
		GPC-2.2. Has mastery of contemporary methods for acquiring and evaluating geochemical information to address theoretical and applied problems of environmental geochemistry in the fields of ecology and nature management for environmental protection purposes;
		GPC-2.3. Possesses foundational knowledge of fundamental branches of biology to the extent required for mastering the principles of ecology and natural resource management;
		GPC-2.4. Analyzes the existing system of environmental regulation for various domains of natural resource management;
		GPC-2.5 Identifies and describes biological diversity, and renders assessments employing modern quantitative information processing methods.
PC-2	The ability to organize and manage the activities of the enterprise using in-depth knowledge in the field of environmental management	PC-2.1. Capable of assessing the natural, technogenic, socio-economic, demographic, and medico-biological situation, and of conducting searches for cultural heritage objects within the territory under investigation;
		PC-2.2. Capable of forecasting potential adverse changes in the natural and technogenic environment, and of performing a preliminary analysis of the implications of information derived from research;
		PC-2.3 Has mastery of skills required for conducting environmental analyses of objects based on chemical, microbiological, parasitological, and toxicological parameters;

		PC-2.4 Capable of collecting and analyzing environmental information concerning the natural and technogenic environment, as well as physiographic and climatic conditions, on the basis of materials from prior years' work.
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3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The discipline "MSW Recycling and Utilization Technics" is allocated to the mandatory component of Block 1 "Disciplines (Modules)" of the higher education program.

Within the context of the higher education program, students also engage with other disciplines and/or practical training activities that facilitate the attainment of the intended learning outcomes of the course "MSW Recycling and Utilization Technics."

Table 3.1. Inventory of higher education program components that support the achievement of the planned learning outcomes of the discipline.

Core	Name of competence	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
GPC-1	Capable of employing philosophical concepts and the methodology of scientific cognition in the study of different levels of organization of matter, space, and time.	Philosophical problems of natural sciences; Methodology of Scientific Creation; Research Work; Work Experience Internship;	Pre-Graduation Practice;
GPC-2	Capable of utilizing specialized and novel areas of ecology, geoecology, and nature management in addressing scientific-research and applied problems within professional practice.	Regional & Municipal MSW Management Systems; Research Work; Work Experience Internship;	Pre-Graduation Practice;

PC-1	The ability to solve the problems of professional activity in the field of ecology, nature management and nature conservation using information and communication, including geoinformation technologies	Pre-Graduation Practice;	Pre-Graduation Practice;
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4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The course workload is 4 credit units.

Table 4.1. Types of educational work by periods of mastering EP VO for **full**-time education

Types of academic activities	Total hours	Semester(s)			
		1	2	3	4
<i>Contact academic hours.</i>	54		54		
Lectures	18		18		
Lab works					
Seminars (workshops/tutorials)	36		36		
<i>Self-study</i>	78		78		
<i>Evaluation and assessment (exam; pass/fail grading)</i>	12		12		
Total course workload	hours	144	144		
	credits	4	4		

5. COURSE CONTENT

Table 5.1. The content of the discipline (module) by type of educational work

Name of the discipline section	Contents of the section (topic)	Type of study*
Section 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. Secondary raw materials. Technology for the production of secondary raw materials.	L, S

	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.	L, S
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.	L, S
	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	L, S
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.	L, S
	Topic 3.2 Microbiological decomposition of bioorganic waste. Composting (stages, technics and equipment, parameters, products). Methane digestion (stages, conditions, products).	L, S
	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.	

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Audience type	Audience equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	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
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	
For independent work of students	An auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the EIOS.	

7. RECOMMENDED SOURCES FOR COURSE STUDIES

Main reading:

1. Waste or resource? Investigating the interplay of structural d waste managers' household food waste interventions. Esther Landells Gamithri G Karunasen Samuel Oakden Anjum Naweed PLoS ONE, 2024 Издательство: Public Library of Science (PLoS) ЭБС РУДН
2. A Handbook for Entrepreneurs on Solid Waste Management: A Step towards Atmanirbhar Bharat Singh Shyamili Jain Ashish Pasi Nidhi Kaushik Garima 2022 Издательство: Cambridge Scholars Publishing 151 стр. ЭБС РУДН

Additional reading:

1. Industrial Waste : Characterization, Modification and Applications of Residues Herbert Pöllmann: De Gruyter ЭБС РУДН
2. Waste Recycling: Waste to Energy System Basheer Abdulrazzak Ghani Nadhim Mejbil Faleh Al-Bāhir, 2023 Издательство: University of AlKafeel Doris Baah, Kharlamova M. Oilspill response on the western region of Ghana: environmental manegement problems [Text] - 2016. - No. 3. - P. 83 - 92. Article Electronic text data <http://journals.rudn.ru/ecology/article/view/14453/13589>
2. Applied ecobiotechnology: textbook in 2 volumes, v.1./A.E. Kuznetsov, N.B. Gradova, S.V. Lushnikov and others - M .: BINOM, Knowledge Laboratory, 2010.- 629 p.: ill.
7. Applied ecobiotechnology: textbook in 2 volumes, v.2./A.E. Kuznetsov, N.B.

Gradova, S.V. Lushnikov and others. -M.: BINOM, Knowledge Laboratory, 2010.- 485 p.: ill.

Internet-based sources

1. **I-versity** platform (Springer Nature): course “Practical Tools of Solid Waste Management and Environmental Damage Reducing” by Kharlamova M.D. (RUDN UNIVERSITY). URL: <https://iversity.org/en/courses/practicaltools-of-solid-waste-management-environmental-damage-reducing>
2. Coursera platform: course “Municipal Solid Waste Management in Developing Countries” URL: <https://www.coursera.org/learn/solid-wastemanagement?>
3. 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"
4. 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/)

Educational and methodological materials for independent work of students in the development of the discipline/module:*

1. A course of lectures on the discipline "MSW Recycling and Utilization Technics".

8. MID-TERM ASSESSMENT AND EVALUATION TOOLKIT

Evaluation materials and a point-rating system* for evaluating the level of competencies (parts of competencies) based on the results of mastering the discipline “MSW Recycling and Utilization Technics” are presented in the Appendix to this Work Program of the discipline.

DEVELOPER:

Ass. Professor of the ES&PQM
Department

Position

Kharlamova M.D.

Surname I.O.

Signature

HEAD OF DEPARTMENT:

Director of ES&PQM
Department

Position

Savenkova E.V.

Name, Surname

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HEAD OF PROGRAMME:

Ass. Prof. of the NM Department

Position

Kapralova D.O.

Name, Surname

Signature