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**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA BY P. LUMUMBA
(RUDN UNIVERSITY)**

Institute of Environmental Engineering

COURSE SYLLABUS

Climate Neutrality and Waste Management

Recommended by the Didactic Council for the Education Field of:
05.04.06 "Ecology and Nature Management"

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

Climate Project Management

1.1. COURSE GOAL(s)

The goal of mastering the discipline "Climate Neutrality and Waste Management" is the formation of knowledge, skills and abilities in the field of processing and disposal of hazardous and municipal waste, taking into account impact onto climate change, and the study of modern technological equipment. The course program includes studying the sources of waste generation and their composition, the main types of waste, their brief description, the principles of classification and subsequent processing, methods of mechanical processing and sorting, thermal utilization, including direct (layer) combustion, various types of pyrolysis, gasification, features of incineration of solid and liquid combustible wastes. Separately, the methods of processing and disposal of sewage sludge are considered, depending on humidity, density, fluidity and contamination. The discipline program also includes consideration of the features of bioorganic waste management, including methods for the safe disposal of municipal solid waste. The course analyzes the features of the formation of greenhouse gases in landfills and dumps.

2. REQUIREMENTS FOR LEARNING OUTCOMES

The process of studying the discipline is aimed at the formation of the following competencies:

Competence code	Competence descriptor	Competence formation indicators
GPC-6	Able to design, present, defend and disseminate the results of his professional activities, including research	GPC-6.1 Able to obtain, analyze, summarize the necessary scientific information using modern research methods, present his own results in the form of scientific articles and public speeches
PC-2	Able to develop and economically justify plans for the introduction of new environmental equipment and technologies to achieve carbon neutrality of the enterprise	PC-2.2 Able to economically justify plans for introducing new equipment and technologies to reduce greenhouse gas emissions PC-2.3 Possesses the skills to select and implement the best available technologies (BAT) to reduce the risks associated with climate change
PC-4	Capable to conduct environmental analysis of projects for expansion, reconstruction, modernization of existing production facilities, taking into account the requirements of standards in the field of greenhouse gas management	PC-4.1 Able to carry out calculations of greenhouse gas absorption/emissions and predict their changes depending on the selected technologies
PC-5	Able to develop measures to minimize possible risks of climate change for conducting various types of economic activities	PC-5.3 Ensures the implementation of environmental action plans, including the introduction of technologies taking into account the requirements for reducing greenhouse gas emissions

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Course "Climate Neutrality and Waste Management" refers to the *variable* component (Block 1).

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*
GPC-6	Able to design, present, defend and disseminate the results of his professional activities, including research	International Standards for GHG Management Carbon Cycles	Research Work (R&D)
PC-2	Able to develop and economically justify plans for the introduction of new environmental equipment and technologies to achieve carbon neutrality of the enterprise	Environmental Engineering and Climate Change Industrial Internship	Climate Project Development Industrial Internship
PC-4	Capable to conduct environmental analysis of projects for expansion, reconstruction, modernization of existing production facilities, taking into account the requirements of standards in the field of greenhouse gas management	Climate Change Models	Climate Project Development
PC-5	Able to develop measures to minimize possible risks of climate change for conducting various types of economic activities	Environmental Engineering and Climate Change Industrial Internship	Research Work (R&D)

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course 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>	68			68	
Lectures	34			34	
Lab works					
Seminars (workshops/tutorials)	34			34	
<i>Self-study</i>	47			47	
<i>Evaluation and assessment (exam; pass/fail grading)</i>	27			27	

Types of academic activities		Total hours	Semester(s)			
			1	2	3	4
Total course workload	hours	108			108	
	credits	3			3	

5. COURSE CONTENTS

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

Title of Course Modules	Content	Types of academic activities
Section 1. INTRODUCTION: WASTE MANAGEMENT ISSUES AND SOLUTIONS	Topic 1.1. Sources of waste generation and impact on the environment and climate change. 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. Greenhouse gases formation processes: stages and products	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. Classification of materials and equipment for its implementation. Goals of waste processing. Waste shredding: crushing and grinding, milling. Crushing stages, basic regularities. Large medium and fine crushing. Compacting and pressing.	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: PROCESSING	Topic 3.1. Thermal processing of waste. Obtaining granulated fuel (RDF). Fire method of waste processing. Incineration of solid combustible waste. Classification of combustion methods. Equipment for fire neutralization and waste processing. Waste pyrolysis. Waste gasification.	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.	L, S

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 projector, laptop, projection screen, stable wireless
Seminars	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 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
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. RESOURCES RECOMMENDED FOR COURSE STUDY

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), ELS of RUDN University

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 p., ELS of RUDN University

Additional reading:

1. Industrial Waste: Characterization, Modification and Applications of Residues Herbert Pöllmann 2021, De Gruyter, ELS of RUDN University

2. Waste Recycling: Waste to Energy System Basheer Abdulrazzak Ghani Nadhim Mejbil Faleh Al-Bāhir, 2023, University of AlKafeel, ELS of RUDN University

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/>
 - Google search engine <https://www.google.ru/>
 - abstract database SCOPUS <http://www.elsevier.com/locate/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 "Climate Neutrality and Waste Management".

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL UPON COURSE COMPLETION

The assessment toolkit and the grading system to evaluate the level of competences (competences in part) formation as results of mastering the discipline are specified in the Appendix to the syllabus.

DEVELOPER:

Associate Professor of the ES&PQM Department		Kharlamova M.D.
Position	Signature	Surname I.O.

HEAD OF DEPARTMENT:

Director of ES&PQM Department		Savenkova E.V.
Position	Signature	Name, Surname

HEAD OF PROGRAMME:

Director of ES&PQM Department		Savenkova E.V.
Position	Signature	Name, Surname

**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE
LUMUMBA
(RUDN UNIVERSITY)**

Institute of Environmental Engineering

ASSESSMENT TOOLKIT

Climate Neutrality and Waste Management

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

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

Climate Project Management

Passport to Assessment Toolkit for Course Climate Neutrality and Waste Management

Education Field / Speciality 05.04.06 "Ecology and nature management"/ «Climate Project Management»

Course: Climate Neutrality and Waste Management

Competences in part (competences in part) under assessment	Course module under assessment	Course topic under assessment	Tools to assess higher education programme mastering level				
			Work at the seminars	Homework	Test	Group work project	Exam/Pass-fail assessment
GPC-6.1 PC-5.3 PC-4.1	Module 1: INTRODUCTION: WASTE MANAGEMENT ISSUES AND SOLUTIONS	Topic 1: Waste in circular economy and climate change. Concepts and basic principles of resource saving.	4	1		5	
		Topic 2: Technologies for municipal solid waste (MSW) and industrial waste processing. General characteristics of technologies	4	1		5	
PC-2.2; PC-2.3 PC-5.3	Module 2: NON-ORGANIC WASTE PROCESSING	Topic 1: Methods for the preparation and processing of solid waste. Classification of materials and equipment for its implementation.	4	1		5	
		Topic 2: Waste separation technics and equipment. Principles of classification. Hydraulic and air classification and equipment for implementation	4	1		5	

PC-2.2; PC-2.3 PC-5.3 PC-4.1	Module 3: ORGANIC WASTE: PROCESSING	Topic 1: Thermal processing of waste. Incineration of solid combustible waste. Classification of combustion methods. Waste pyrolysis	4	1		5	
		Topic 2: Microbiological decomposition of bioorganic waste. Composting (stages, technics and equipment, parameters, products). Methane digestion (stages, conditions, products).	4	1		5	
		Topic 3: Sewage sludge management and processing. Sludge Treatment Processes: Compaction, Stabilization, Conditioning, Dewatering, Decontamination and Neutralization.	4	1		5	
		TOTAL	28	7	16	35	14

Course Climate Neutrality and Waste Management

QUESTION CARD No 1

QUESTION 1 Organic matter in the Environment. Biogeochemical cycles of nitrogen and phosphorous. Processes of methane digestion: stages and bacterial gropes.

QUESTION 2 The main types of waste, their brief characteristics, the principles of classification and processing

Developer _____ (Kharlamova M.D.)
signature

Head of Educational Department _____ (Savenkova E.V.)
signature

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)

EXAM QUESTIONS

1. Stability and safety of the environment (OS), Principles of stability of the biosphere.
2. The concept of waste. The main types of waste, their brief characteristics, principles of waste classification.
3. Waste management processes (waste life cycle). Organization of waste management.
4. Waste and climate change: problems and solutions
5. Documentation of waste management activities. Certification and certification of waste. Certification of hazardous waste.
6. The cycle of substances is an important principle of ecosystem sustainability. Nutrients. Biogeochemical cycle of carbon.
7. Biogeochemical cycles of hydrogen and oxygen.
8. Biogeochemical cycles of nitrogen and sulfur,
9. Biogeochemical cycles of phosphorus and metals.
10. Self-cleaning ability of ecosystems: biotic and abiotic processes. Activity of microorganisms in soil, water, air. Ecosystem stability parameters.
11. Sewage sludge and methods of their processing and disposal.
12. Biological methods of processing. Methane fermentation. Composting.
13. Thermal methods of waste neutralization. Types and principles of processing. Arrangement of technological equipment.
14. Sources of formation and methods for processing waste with a high content of organic substances. Specificity of processing methods.
15. Bioenergy on waste (chemical oxidation, thermal gas generation, biological fermentation).

16. Processing of agricultural waste. Biogas power plants. Aerobic and anaerobic methods of disinfection of agricultural wastes.
17. Principles and types of bio-organic waste processing. Technologies of biothermal aerobic composting. Bio-composting.
18. Technologies for processing domestic garbage. Warehousing and burial. Landfills: requirements, design principles.
19. Methods of incineration of solid waste. Receiving energy. Ecological aspects of combustion.
20. Technologies of anaerobic digestion and production of biogas at landfills. Equipment for methane digestion.
21. Calculation approach for landfill greenhouse gas formation
22. Calculation approach for landfill's parameters.
23. Technologies for processing waste containing plastic bottles (PET polyethylene terephthalate), waste paper, scrap metal, bottle glass and glass bottles.
24. Classification of urban wastes. Municipal waste management systems.
25. The main types of waste, their brief characteristics, the principles of classification and processing
26. General principles and methods for processing of non-radioactive waste
27. Features of preparation and mechanical treatment of solid household waste
28. Milling and compacting of solid municipal waste
29. Processes of "dry" mechanized separation (sorting) of MSW
30. Schemes of solid waste' complex sorting and processing
31. Specificity of Monitoring Programs in the Waste Management System

Tentative list of assessment tools

No	Assessment tool	Brief features	Assessment tool representation in the kit
<i>Class work</i>			
1	Survey/Quiz	A tool of control, organised as a special conversation between a teacher and students on topics related to the course under study, and designed to clarify the amount of students' knowledge in a particular section, topic, problem, etc.	Questions on the course topics /modules
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
3	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
4	Round table, discussion, polemic, dispute, debate, (class work)	Evaluation tools that allow the teacher to engage students in the process of discussing controversial issues, problems and assess their ability to argue their own point of view.	List of themes for round tables, discussions, polemics, disputes, debates.
5	Business game and/or role play	Joint activities of a student group under the teacher's control to solve educational and professionally oriented tasks through the simulation of a real-world problem; this activity allows the teacher to assess the students' ability to analyse and solve typical professional challenges.	Topic (problem), concept, roles and expected results for each game
6.	Presentation (defence) of project/report/ Library research paper /briefs *	A tool for monitoring the students' ability to present the work results to the audience.	Themes for projects/reports/ Library research paper/ briefs
7	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
8	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	Examples of tasks/questions/exam question cards

		thinking, ability to synthesise the acquired knowledge and apply it to solve practice tasks.	
9	Case	A problem-solving task in which the student is asked to comprehend the real work-related (occupational) situation necessary to solve the problem.	Assignments to solve the case
10	Multi-level tasks and assignments with varying difficulty	The tasks and assignments differ in terms of the following levels: 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, 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, c) creative level allows to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.	Set of multi-level tasks and assignments with varying difficulty
<i>Self- studies</i>			
1	Calculation and graphic work	A tool for checking students' skills in applying the acquired knowledge according to a predetermined methodology in task solving or fulfilling assignments for a module or discipline as a whole.	Set of tasks for calculation and graphic work
2	Course work/project	A type of independent written work aimed at the creative development of general professional and specialised professional disciplines (modules) and the development of relevant professional competences	Course assignment themes
3	Project	The final "product" that results from planning and performance of educational and research tasks set; it allows the teacher to assess the students' ability to independently shape their knowledge in the course of solving practice tasks and problems, navigate in the information environment and the students' level of analytical, research skills, skills of practical and creative thinking; it can be implemented individually or by a group of students.	Themes for team-based or individual projects
4	Reports, briefs	The product of the student's independent work, which is a public performance on the presentation of the results of solving a specific educational, practical, research or scientific topic.	Themes for reports, briefs
5	Standard calculations	A tool to test skills in applying the acquired knowledge, according to a predetermined methodology, solving tasks or fulfilling	Set of tasks for standard calculations

		assignments for a module or discipline as a whole.	
6	Homework	<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 the teacher to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.</p>	Set of multi-level tasks and assignments with varying difficulty

Department of Environmental Safety and Product Quality Management

Set of assignments for control work

for the course Climate Neutrality and Waste Management

1. The information system for maintaining the Waste Cadastre includes the following main blocks:

- a. databank on the presence of restrictions on the location of the waste management facility
- b. catalog data bank
- c. databank of GIS technologies and cartographic materials
- d. vehicle data bank
- e. investor data bank
- f. databank of waste and technologies for their processing
- g. state register of waste disposal facilities

2. To determine the resource characteristics of waste, it is necessary to take into account (add the missing physical and chemical parameters):

- a. waste composition (name and formula of the substance)
- b. hazardous properties of waste
- c. technological processes in which it is possible to use waste
- d.
- e.
- f.

3. Wastes that can be used as SMR and VER are formed mainly at the following stages of the product (item) life cycle:

- a. product development
- b. production of products
- c. product sales
- d. product operation
- e. product repair
- f. waste disposal

4. The main tasks of waste management in accordance with the waste management hierarchy are (put in the required order)

- a. minimization of costs for sanitary cleaning of the city;
- b. selection of environmentally friendly waste processing methods with the lowest economic costs;
- c. the maximum possible involvement of waste in the economic circulation and their material and energy utilization as technogenic raw materials;
- d. minimization of the amount of generated waste;
- e. gradual transition from landfill disposal of solid waste to industrial processing.

5. Obligatory processes providing a comprehensive scheme for MSW processing are:

- a. separate collection
- b. organization of transportation without increasing the shoulder of removal
- c. organization of transportation from equidistant objects
- d. mechanical separation
- e. mechanical grinding
- f. biothermal processing (composting, anaerobic digestion)
- g. thermal processing

Assessment criteria:

(in compliance with the legal regulations in force)

Developer _____ (Marianna Kharlamova)
signature

day, month, year

Department of Environmental Safety and Product Quality Management

TEAM-BASED OR INDIVIDUAL CREATIVE ASSIGNMENTS/PROJECTS

for the course Climate Neutrality and Waste Management

Task for team-based or individual creative assignments/projects

At the **first workshop**, the group prepares a report on the problems of the selected type of production (industry) and ways to minimize waste from this production (including solid waste, wastewater and gas emissions)

At the **second workshop**, the groups analyze the scheme of the main technological process and identify all possible organized sources of waste generation in production.

At the **third workshop**, the groups analyze modern methods of complex preparation of waste for disposal for a selected group of wastes and methods for utilizing resource or energy potential.

At the **fourth workshop**, the groups prepare a comprehensive scheme for the preparation and subsequent disposal of waste from the selected production or MSW fractions.

At the **fifth workshop**, the groups get acquainted with the methodology for estimating (calculating) production costs and calculate the cost of capital and operating costs for organizing the proposed scheme for the preparation and disposal of waste.

At the **sixth workshop**, the groups assess the amount of waste that remains unutilized and that should be disposed of, as well as assess the parameters of the landfill.

Assessment criteria:

(in compliance with the legal regulations in force)

DEVELOPER:

Associate 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:

Director of ES&PQM
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Position

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Name, Surname

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