



## Waste management

### Work program of the discipline (Syllabus)

#### Details of the discipline

Level of higher education	<i>Second (master's)</i>
Field of knowledge	<i>10 Natural sciences</i>
Speciality	<i>101 Ecology</i>
Educational program	<i>Environmental safety</i>
Discipline status	<i>Required</i>
Form of study	<i>full-time (day)/remote/mixed</i>
Year of preparation, semester	<i>1st year, autumn semester</i>
Scope of discipline	<i>6 ECTS credits (180 hours)</i>
Semester control/control measures	<i>Exam</i>
Schedule of classes	<i>5 hours a week (2 hours lectures, 2 hours of laboratory and 1 hour of practical classes)</i>
Language of instruction	<i>Ukrainian</i>
Information about the course / teachers	Lecturer: <a href="https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyky/radovenchik-vyacheslav-mikhajlovich.html">https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyky/radovenchik-vyacheslav-mikhajlovich.html</a> Practical /Seminar/Laboratory: <a href="https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyky/radovenchik-vyacheslav-mikhajlovich.html">https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyky/radovenchik-vyacheslav-mikhajlovich.html</a>
Course placement	<a href="https://do.ipk.kpi.ua/course/view.php?id=3364">https://do.ipk.kpi.ua/course/view.php?id=3364</a>

#### The program of the discipline

##### 1. Description of the discipline, its purpose, subject of study and learning outcomes

*Solid household waste has always been formed as a result of human life processes. Since in the early stages of the development of human society it used and consumed only products of natural origin and lived dispersedly, solid waste did not bother him much. The simplest small volumes of such waste could be eliminated by incineration or disposal. Intensive urbanization and the use of a significant amount of artificial substances began to exacerbate the problem of solid household waste. The first problems of solid household waste were large-scale epidemics caused by their pre-carriers, which multiplied en masse in piles of garbage – rats, bedbugs, fleas, etc. with an increase in the volume of solid household waste accumulation, problems began to arise with odors and smoke in the surrounding areas during self-ignition of landfills. how their negative impact was further exacerbated.*

*Today, the use of a significant amount of substances and materials that are not typical for the environment, such as nutrients, household chemicals, unsuitable medicines and medications, worn-out household appliances, etc. have led to pollution of the main components of the environment - soils, air, surface and groundwater. garbage.*

*The resource saving factor is becoming increasingly important in the problems of solid household waste, since the composition of waste changes significantly and they can go into the category of man-made deposits in individual components, and the economic factor, since waste recycling can, in some cases, bring quite significant profits.*

*The subject of the discipline "Waste management" is the implementation of technical and technological approaches that guarantee a stable and safe protection of humanity from the negative effects of solid household waste.*

*To a large extent, the solution of these problems will be determined by the level of training of specialists working in the field of environmental protection, including state environmental safety management institutions, scientific institutions and organizations, enterprises.*

*To successfully solve the problems of protecting and preserving the environment while ensuring the stable development of mankind, specialists must be fluent in information, be able to solve complex problems of protecting the environment from pollution at the highest technological and scientific level.*

#### ***The purpose of the discipline "Waste management"***

*The purpose of studying this discipline is to form in the masters a set of knowledge in the field of modern technologies for the collection, transportation, processing and disposal of solid household waste, scientific developments in the field of increasing the efficiency of the use of natural material and energy resources, a set of skills and abilities necessary for the introduction into production and management of modern and new we are the method of solid waste management and technology, the creation of effective systems for their disposal and storage.*

- *the ability to assess the level of negative impact of natural and anthropogenic factors of environmental hazard on the environment and humans (C 18).*
- *ability to organize work related to environmental assessment, environmental protection and environmental optimization, in conditions of incomplete information and conflicting requirements (C 15).*
- *the ability to develop a complex of management solutions (C 19).*

*According to the requirements of the program of the discipline "Waste management", students after mastering it must demonstrate the following programmatic learning outcomes:*

- *demonstrate awareness of the latest principles and methods of environmental protection (PO 10);*
- *to be able to use modern information resources on ecology, nature management and environmental protection (PO 11);*
- *to be able to assess landscape and biological diversity and analyze the consequences of anthropogenic impact on natural environments (PO 12);*
- *to be able to assess the potential impact of man-made objects and economic activities on the environment (PO 13);*
- *assess environmental risks in case of insufficient information and conflicting requirements (PO 15);*
- *choose the optimal strategy of management and / or environmental management depending on environmental conditions (PO 16).*
- *using scientific and technical information, regulatory documents, professional knowledge, apply methods of managing technological processes, equipment that protect water bodies, atmosphere, soils and subsoil from pollution and harmful effects (PO 23);*
- *on the basis of regulatory provisions of environmental standardization and certification, work with Ukrainian and foreign standards and certification requirements to develop relevant professional recommendations (PO 24).*

## **2. Prerequisites and post-requisitions of disciplines (place in the structural and logical scheme of education according to the relevant educational program)**

*The study of the discipline "Waste management" is based on the principles of integration of various knowledge gained by students during their studies in bachelor. The discipline "Waste management" provides internships, as well as the implementation of master's work.*

## **3. Contents**

### ***Section 1. Condition and composition of municipal solid waste***

*The formation of household waste. Dynamics of household waste generation in Ukraine and the world. Norms of household waste generation. Morphological composition of household waste. Fractional composition of household waste and other properties.*

### **Section 2. Collection and transportation of municipal solid waste**

*Sources of solid waste. Gross and separate waste collection. Equipment for waste collection. Collection of solid waste in residential buildings. The structure of the garbage chute and its maintenance. Calculation of the number of containers. Oversized waste and equipment for their collection. Vehicles for moving waste. Garbage handling stations. Pneumatic and hydrotransport waste.*

### **Section 3. Solid waste disposal**

*The concept of solid waste storage. Solid waste storage facilities in Ukraine. Landfills. Placement of polygons. Block diagram of the polygon. Types of polygons. Arrangement of landfills. Ecological system of landfills. Stages of decomposition of solid waste. Methods of processing filtering landfills. Technologies for processing solid waste with biogas production. Operation and reclamation of landfills.*

### **Section 4. Sorting of municipal solid waste**

*The concept of material and raw material recycling. Solid waste sorting systems. Hazardous household waste. Processing of solid waste components. Labeling of packaging materials.*

### **Section .5. Thermal methods of municipal solid waste disposal**

*The main methods of thermal neutralization of solid waste. The structure of incinerators. Environmental aspects of direct combustion of solid waste. Solid waste pyrolysis. Gasification of solid waste. Neutralization of solid waste by processing slag in the melt. Plasma neutralization of solid waste.*

### **Section .6. Biological methods of solid waste disposal**

*Composting solid waste. Plants of biothermal composting of solid waste. The use of vermiculture for the disposal of solid waste. Prospects for the development of technologies for the neutralization of solid waste.*

## **4. Learning materials and resources**

### **Basic**

1. Radovenchyk V.M., Gomel M.D. *Solid waste: collection, processing, warehousing.* – Kyiv: Condor, 2010. – 549 p.
2. Law of Ukraine "On Waste", No. 187/98 – Verkhovna Rada of March 5, 1998
3. Radovenchyk V.M., Poberezhnyi M.V., Radovenchyk Y.V., Kutsak K.A. *Peculiarities of solid waste management on the territory of Ukraine // Municipal economy of cities, 2019.* – issue. 147. – vol. 1. – P. 94 – 100. DOI 10.33042/2522-1809-2019-1-147-94-100.
4. Radovenchyk V.M., Poberezhnyi M.V., Radovenchyk Y.V., Krysenko T.V. *Disposal of solid household waste on the territory of Ukraine in 2018 // Municipal economy of cities, 2019.* – issue. 152. – vol. 6. – P. 67 – 72. DOI 10.33042/2522-1809-2019-6-152-67-72.
5. *Waste management: Course of lectures. For full-time students. Specialty 101 "Ecology" / O. V. Fishing.* - H.: NUTSU, 2016. – 530 p.

### **Further reading.**

6. *Waste management and management: Textbook / T.P. Shanina, O.R. Gubanova, M.O. Klimenko, T.A. Safranov, V.Y. Korinevskaya, O.O. Bedunkova, A.I. Volkov. Ed. T.A.Safranova, M.O. Klymenko,* - Odessa: ODEU, 2011. □ 258 p.
7. *Best European Practices in Waste Management (Guide) / A. VoyTsikhovska, O. Kravchenko, O. Melen-Zabramna, M. Pankevych, [edited by O. Kravchenko] — Publishing House □Company "Manuscript"□ — Lviv, 2019. — 64 p.*

8. *Norms of solid waste generation for settlements of Ukraine.* – Order of the Ministry of Construction of Ukraine No7 of 10.01.06 – 14 p.
9. *DBN V.2.4.* – 2005. *Solid waste landfills. Fundamentals of design.* – K., 2006. – 35 p.
10. Mikulyonok I.O., Ryabtsev G.L. *Basic methods and ways of using polymer-containing waste // Scientific news of NTUU "KPI".* – 2001. - №2. – P.135 – 147.

### **Information resources on the Internet**

1. *Ministry of Environmental Protection and Natural Resources in Ukraine* - <https://mepr.gov.ua>.
2. *Industrial Ecology. Community of Environmental Specialists* - <http://www.eco.com.ua/>
3. *Professional Association of Ecologists of Ukraine (PAEU)* - <https://paeu.com.ua>.
4. *Ministry for Communities and Territories Development* - <https://www.minregion.gov.ua>.
5. *Communal enterprise "Kyivkomunservice"* - <https://kks.kiev.ua>.

## **Educational content**

### **5. Methods of mastering the discipline (educational component)**

#### **Lectures**

*Lectures are aimed at:*

- *providing modern, holistic, interdependent knowledge of the discipline "Waste Management", the level of which is determined by the target setting for each specific topic;*
- *ensuring in the process of the lecture the creative work of students together with the teacher;*
- *education of students' professional and business qualities and the development of their independent creative thinking;*
- *formation of students' necessary interest and providing direction for independent work;*
- *determining the current level of development of science in the field of waste management, forecasting its development for the coming years;*
- *reflection of the methodological processing of the material (selection of the main provisions, conclusions, recommendations, clear and adequate to their formulations);*
- *use for demonstration of visual materials, combination, if possible, them with a demonstration of results and samples;*
- *teaching materials in a clear and high-quality language in compliance with structural and logical connections, explaining all newly introduced terms and concepts;*
- *accessibility for perception by this audience.*

<b>No s/n</b>	<b>The title of the lecture topic and the list of main issues (list of didactic tools, references to literature and tasks for the IWC)</b>	<b>Hours</b>
1-2	<p><u>Condition and composition of municipal solid waste. Generation of household waste. Dynamics of household waste generation in Ukraine and the world. Norms of household waste generation. Morphological composition of household waste. fractional composition of household waste and other properties.</u></p> <p><b>Literature: 1 [303-314], 3.</b></p> <p><u>Tasks for IWC:</u> Basic properties of household waste. Calorific value of solid household waste. 5 [57-72], 6 [138-149].</p>	4
3-4	<p><u>Collection and transportation of solid household waste. Sources of solid waste formation. Gross and separate collection of waste. Equipment for waste collection. Collection of solid waste in residential buildings.</u></p> <p><b>Literature: 1 [314-340], 6 [149-160].</b></p> <p><u>Tasks for IWC:</u> Quality of household waste collected in various ways. Experience in separate waste collection. 7 [19-33], 3.</p>	4

5-6	<p><u>Collection and transportation of solid household waste</u> Calculation of the number of containers. Oversized waste and equipment for their collection. Vehicles for the movement of waste. Garbage handling stations. pneumatic and hydrotransport waste.</p> <p><b>Literature: 1 [314-344], 6 [149-160].</b></p> <p><u>Tasks for IWC:</u> The main types of containers, their production in Ukraine and abroad. 1 [323-334].</p>	4
7-8	<p><u>Solid waste disposal.</u> Concept of solid waste storage. Solid waste storage facilities in Ukraine. Landfills. Location of landfills. Block diagram of landfills. Types of landfills.</p> <p><b>Literature: 1 [34 4-361], 5 [239-249].</b></p> <p><u>Tasks on the IWC:</u> Methods for the formation of waterproofing screens when creating polygons. 5[235-239], 9.</p>	4
9-10	<p><u>Solid waste disposal.</u> Ecological system of landfills. Stages of decomposition of solid waste. Methods of processing filtrates of landfills. Technologies of processing solid waste with biogas production. Operation and reclamation of landfills.</p> <p><b>Literature: 1 [357-388], 5 [239-249].</b></p> <p><u>Tasks at the IWC:</u> – Impact of solid waste landfills on environmental elements. 5 [126-148], 7 [33-51].</p>	4
12-13	<p><u>Sorting of municipal solid waste.</u> The concept of material and raw material recycling. Experience of waste sorting on the territory of Ukraine. Solid waste sorting systems. Apartment and office level of sorting systems. yard level of sorting systems.</p> <p><b>Literature: 1 [389-404], 3, 4.</b></p> <p><u>Tasks for IWC:</u> – Sorting of solid household waste abroad. Disadvantages of different levels of sorting. Quality of secondary raw materials. 7 [51-57].</p>	4
14	<p><u>Sorting of municipal solid waste.</u> Hazardous household waste. Processing of components of solid waste. Labeling of packaging materials.</p> <p><b>Literature: 1 [404-468], 5 [112-126].</b></p> <p><u>Tasks for IWC:</u> – Use of waste paper, plastics, glass and organic waste as secondary raw materials. 6 [185-209], 7 [20-26].</p>	4
15-16	<p><u>Thermal methods of neutralization of solid household waste.</u> The main methods of thermal neutralization of solid waste. Structure of incinerators. Environmental aspects of direct combustion of solid waste. Pyrolysis of solid waste. Gasification of solid waste. Neutralization of solid waste by processing in melt slag. Plasma neutralization of solid waste.</p> <p><b>Literature: 1 [468-499], 5 [304-334].</b></p> <p><u>Tasks for IWC:</u> – Harmful substances formed during the combustion of solid waste. Furana and dioxins. 5 [36-53], 7 [33-51].</p>	4
17-18	<p><u>Biological methods of solid waste disposal.</u> Composting solid waste. Plants of biothermal composting of solid waste. Use of vermiculture for the neutralization of solid waste. Prospects for the development of technologies for the neutralization of solid waste.</p> <p><b>Literature: 1 [499-522].</b></p> <p><u>Tasks for IWC:</u> – Properties of secondary products of biological methods of processing solid waste and its use. 7 [19-33].</p>	4
	<b>Just</b>	<b>36</b>

### Practical classes

In the system of professional training of students in this discipline, practical classes occupy 20% of the classroom load. Use special terminology, allow you to check knowledge therefore, this type of work is an important means of operational feedback. Practical classes should perform not only cognitive and

educational functions, but also contribute to the growth of students as creative workers in the field of environmental protection.

The main objectives of the cycle of practical classes:

- help students to systematize, consolidate and deepen their theoretical knowledge in the field of modern methods of solid waste management;
- teach students techniques for solving practical problems, promote mastering the skills and abilities of performing calculations, graphic and other tasks;
- teach them to work with scientific and reference literature and diagrams;
- to form the ability to learn independently, that is, to master the methods, methods and techniques of self-learning, self-development and self-control.

No s/n	The name of the topic of the lesson and the list of main questions (list of didactic support, references to literature and tasks for the IWC)	Hours
1	The composition of the project of the landfill of solid household waste. Calculation of the required area of the site (2 hours). <b>Literature: 8; 9.</b> Tasks for IWC – Stages of designing landfills. Selection of a site of territory [9 p. 4-11].	2
2	Design of the warehousing site (2 hours). <b>Literature: 1. pp. 350-358; 9.</b> The task on the IWC is the anthropogenic impact of landfills on the environment [1 p. 456-363].	2
3	Forecast of anthropogenic impact of the landfill in TPV on the components of the natural environment. Engineering solutions for environmental protection (4 hours). <b>Literature: 1. pp. 308-315; 9.</b> The task on the IWC is the Classification of geosynthetic materials [1 p. 89-102]..	4
4	Protective screens of polygons (4 hours). <b>Literature: 1. pp. 117-130; 9.</b> The task on the IWC is to arrange anti-filtration screens [9].	4
5	Internal drainage and filtrate removal system. Polygon degassing system (4 hours). <b>Literature: 1. pp. 362-384; 9.</b> The task at the IWC is the Administrative, economic and protective zones of the landfill [9].	4
6	Modular control work	2
	<b>Just</b>	18

### Laboratory classes

The main objectives of the cycle of laboratory classes:

In the system of professional training of students, laboratory classes occupy 40% of the classroom load. Laboratory works are designed to deepen the assimilation of theoretical material and obtain independent practical skills in solid waste management as a result of experimental work in the laboratory.

No s/n	The name of the topic of the lesson and the list of main questions (list of didactic support, references to literature and tasks for the IWC)	Hours
1	Classification of granular materials (6 hours). <b>Literature: 1. pp. 37-47.</b> Tasks for IWC – Sifting and classification [5 c. 282-299].	6

2	<i>Determination of the granulometric composition of dispersed suspensions (8 hours). <b>Literature: 1. pp.37-50.</b> Tasks for IWC – Sifting and classification [5 c. 282-299].</i>	8
3	<i>Determination of waste moisture (6 hours). <b>Literature: 1. pp. 308-315.</b> Task on IWC – Properties of municipal solid waste [6 p. 138-145].</i>	6
4	<i>Determination of morphological, fractional composition, humidity, density, calorific value of solid household waste (12 hours). <b>Literature: 1. pp. 307-315.</b> Tasks for IWC – Methods of processing municipal waste [5 c. 160-209].</i>	12
5	<i>Determination of the type of plastics (4 hours). <b>Literature: 1. pp. 362-384; 9.</b> The task of the IWC is the recycling of plastics [10].</i>	4
	<i>Just</i>	36

## 6. Independent work of the student

*Independent work of students takes 50% of the time to study the course, also includes preparation for the exam. The main task of students' independent work is to master scientific knowledge in the field of environmental protection, which are not included in the list of lecture questions, through personal search for information, the formation of an active interest in a creative approach in educational work. In the process of independent work within the framework of the credit module, the student must learn to deeply analyze the problems of environmental analysis methods and, based on analyzes, come to their own reasonable conclusions.*

<b>No s/n</b>	<b>The name of the topic submitted for independent study</b>	<b>Number of hours of IWC</b>
<i>Section 1. Condition and composition of municipal solid waste</i>		
1	<i>The main properties of household waste. Calorific value of municipal solid waste. 5 [57-72], 6 [138-149].</i>	11
<i>Section 2. Collection and transportation of municipal solid waste</i>		
2	<i>The quality of household waste collected in various ways. Experience in separate waste collection. 7 [19-33], 3. The main types of containers, their production in Ukraine and abroad. Additional container equipment. 1 [323-334].</i>	8
<i>Section 3. Solid waste disposal</i>		
3	<i>Methods for the formation of waterproofing screens when creating polygons. 5[235-239], 9. The impact of solid waste landfills on environmental elements. Control of the negative impact of polygons. 5 [126-148], 7 [33-51].</i>	11
<i>Section 4. Sorting of municipal solid waste</i>		
4	<i>Sorting of municipal solid waste abroad. Disadvantages of different levels of sorting. The quality of secondary raw materials. 7 [51-57]. Use of waste paper, plastics, glass and organic waste as secondary raw materials. 6 [185-209], 7 [20-26].</i>	8
<i>Section 5. Thermal methods of neutralization of solid waste</i>		
5	<i>Harmful substances formed during the combustion of solid waste. Furans and dioxins. 5 [36-53], 7 [33-51].</i>	9
<i>Section 6. Biological methods of solid waste disposal</i>		

6	<i>Properties of secondary products of biological methods of processing solid waste and its use. 7 [19-33].</i>	9
7	<i>Preparation for the domestic control work and from sections 1-6</i>	6
8	<i>Exam</i>	30
	<b><i>Total hours</i></b>	<b>90</b>

## Policy and control

### 7. Policy of the discipline (educational component)

#### Rules for attending classes and behavior in the classroom

*Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a good reason, not to interfere with the teacher to conduct classes, not to be distracted by actions that are not related to the educational process.*

#### Rules for assigning incentive and penalty points

- *Incentive points can be awarded by the teacher solely for performing creative work in the discipline or additional completion of online specialized courses with the receipt of the appropriate certificate:*
  - <https://www.coursera.org/learn/solid-waste-management>;
  - [https://courses.prometheus.org.ua/courses/course-v1:IRF+WST101+2019\\_T2/about](https://courses.prometheus.org.ua/courses/course-v1:IRF+WST101+2019_T2/about);
  - [https://www.shortcoursesportal.com/studies/297793/environmental-waste-management.html?ref=search\\_card](https://www.shortcoursesportal.com/studies/297793/environmental-waste-management.html?ref=search_card).

*But their amount cannot exceed 10 % of the rating scale.*

#### The ethics of deadlines and rescheduling

*In case of debts in the discipline or any force majeure circumstances, students should contact the teacher through the available (provided by the teacher) communication channels to solve problematic issues and agree on an algorithm of actions for working out.*

#### Academic Integrity Policy

*Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of links when using printed and electronic materials, quotes, opinions of other authors. Unacceptable hints and write-offs when writing tests, conducting classes; passing the exam for another student; copying materials protected by the copyright system without the permission of the author of the work.*

*The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>*

#### Academic Conduct and Ethics Policy

*Students should be tolerant, respect the opinions of others, formulate objections in the correct form, constructively maintain feedback in the classroom.*

*The norms of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>*

### 8. Types of control and rating system for evaluating learning outcomes (RSO)

*Distribution of study time by types of classes and tasks in the discipline in accordance with the working curriculum:*

Semester	Study time		Distribution of study hours				Control measures		
	Loans	acad. H.	Lecture	Practical	Lab. Rob.	IWC	MCT	HCW	Semester control
1	6	180	36	18	36	90	1	–	Exam

*The student's rating on the discipline consists of points that he receives for:*

- 1 - work in laboratory classes;
- 2 - two tests (planned according to the work plan of the MCT is divided into 2 works lasting 45 minutes each);
- 3 - express survey at lecture classes;
- 4 - answers in practical classes;
- 5 – answers on the exam.

**The system of rating (weight) points and evaluation criteria:**

1. Express control at lectures:

Weight score – 5. The maximum number of points when interviewing at a lecture of at least 8 students is  $4 \times 5 = 20$  points.

Criteria for assessing students' knowledge:

<b>Completeness and signs of response</b>	<b>Points</b>
Clear and complete answer to the question	5
The answer made some inaccuracies or errors	4... 3
The answer does not contain the wording of terms, laws and formulas	2... 1
Answer not credited	0

2. Modular control ( $R_m$ )

Weight score – 5. The maximum number of points for sun and tests is equal to: 5 points x 2 works = 10 points

Criteria for evaluating tests

Mark	Completeness of the answer
5	"excellent", creative disclosure of one of the issues, fluency in the material
4	"good", incomplete disclosure of one of the questions or full answer with minor inaccuracies
3	"satisfactory", Incomplete disclosure of the issue (at least 60% of the information required) and minor errors
1-2	Unsatisfactory work (does not meet the requirements for 3 points)
0	Lack of work.

3. Laboratory work:

Weight score – 4. The maximum number of points for all practical work is equal to: 4 points  $\times$  5 l/p = 20 points.

Criteria for assessing students' knowledge:

Completeness and signs of response	Points
Clear and timely execution and design of work	4
Minor inaccuracies were made in the response	3
Mistakes have been made in the work that distort the result	2
Late execution of work, deficiencies in the design	1
Failure to perform laboratory work	0

4. Practical classes:

Weight score – 2. The maximum number of points for all practical work is equal to: 2 points  $\times$  5 p/p = 10 points.

Criteria for assessing students' knowledge:

<i>Completeness and signs of response</i>	<i>Points</i>
<i>Clear and timely execution and design of work</i>	<i>2</i>
<i>Late execution of work, deficiencies in the design</i>	<i>1</i>
<i>Failure to do practical work</i>	<i>0</i>

**Calculation of the scale (R) of the rating:**

The sum of the weight points of the control measures during the semester is:

$$R_c = 20 + 10 + 20 + 10 = 60 \text{ points.}$$

According to the results of educational work in the first 7 weeks, the "ideal student" should score 30 points. At the first certification (8th week), a student receives "enrolled" if his current rating is at least 20 points.

According to the results of educational work for 13 weeks of study, the "ideal student" should score 60 points. At the second certification (14th week), a student receives "enrolled" if his current rating is at least 40 points.

During the exam, students give answers to 4 questions, each of which is estimated at 10 points.

The maximum number of points is  $4 \times 10 = 40$  points.

Thus, the rating assessment in the discipline is:

$$R = 60 + 40 = 100 \text{ points.}$$

Students who have received an F grade are not allowed to take the exam and must increase their rating.

A prerequisite for admission to the exam is the fulfillment of all ICRs.

Criteria for assessing students' knowledge at the exam:

<b>Completeness and signs of response</b>	<b>Points</b>
<i>Full answer to all questions</i>	<i>10</i>
<i>The answer made some inaccuracies</i>	<i>8... 9</i>
<i>This partial answer or in answers to questions and mistakes made</i>	<i>6... 7</i>
<i>This fuzzy answer: missing or made mistakes in formulas, reactions, terms and definitions</i>	<i>4... 5</i>
<i>Unsatisfactory answers to individual questions and the presence of significant errors on other questions are given</i>	<i>1... 3</i>
<i>Answer not credited</i>	<i>0</i>

The sum of the starting points and points for the answer on the exam is transferred to the examination evaluation according to the table:

**Rating scale in the discipline**

$R = r_1 + r_2 + r_3 + r_4$	<i>University scale</i>
<i>95... 100 points</i>	<i>Perfectly</i>
<i>85... 94 points</i>	<i>Very good</i>
<i>75... 84 points</i>	<i>Well</i>
<i>65... 74 points</i>	<i>Satisfactory</i>
<i>60... 64 points</i>	<i>Enough</i>
<i>R &lt; 60 points</i>	<i>Disappointing</i>
<i>If <math>r_c &lt; 40</math> points or other conditions for admission to the test are not met</i>	<i>Not allowed</i>

## 9. Additional information on the discipline (educational component)

### *List of questions for the exam*

1. Describe the environmental problems of municipal solid waste.
2. Explain the fire neutralization of solid waste.
3. Describe the advantages of biogas over other energy carriers.
4. Describe the concept of raw material and material recycling.
5. Explain the apartment-office level of sorting solid waste.
6. Describe the dependence of the morphological composition of solid waste on the level of development of the country.
7. Describe the purpose of portal garbage trucks.
8. Characterize the groups of solid waste by the rate of decomposition. Their half-life.
9. Describe a typical CVD scheme.
10. Explain the structure of the garbage chute.
11. Explain the use of transport garbage trucks.
12. To characterize the categories of landfills.
13. Explain the concept of hazardous household waste.
14. Describe CVD liquid waste.
15. Describe the zoning of the landfill in depth.
16. Characterize the intensity of anaerobic processes in the body of the landfill over time.
17. Describe the unloading and warehousing areas.
18. Explain the main work in the operation of garbage chutes.
19. To characterize the block diagram of the landfill.
20. Describe the main processes in the upper aerobic layer of the polygon.
21. Explain the concepts of "young" and "old" filtrates.
22. Describe the pouring of solid waste at the landfill.
23. Explain the concept of "clean" and "dirty" SSS.
24. Describe CVD solid waste.
25. Explain the environmental aspects of solid waste disposal.
26. Explain anti-filtration measures in the arrangement of landfills.
27. Describe the main processes in the transition zone of the landfill.
28. Describe the main components of solid waste, which is the source for the formation of biogas.
29. Describe the biogas collection system.
30. Characterize the control of air pollution over the landfill.
31. Characterize CVD gaseous waste.
32. Characterize vermicultivation in the processes of processing solid waste.
33. Characterize the gross yield of solid waste .
34. To characterize the concept of highly loaded landfills.
35. Explain the main processes in the anaerobic zone of the polygon.
36. Explain the reasons for the formation of filtrates of landfills.
37. Explain the device of wells for the selection of biogas when pouring solid waste.
38. To characterize the lines of manual sorting of solid waste
39. Describe the "2 seconds rule".
40. Characterize the density of solid waste.
41. Describe the separate collection of solid waste .
42. Explain the classes of waste taken to landfills.
43. Describe the queues and complexes of landfills.
44. To characterize the membrane technology of disinfection of filtrates.
45. To characterize the installation of wells for biogas sampling at closed landfills.
46. To characterize the control of groundwater pollution in the area of the landfill.
47. Explain the fire and plasma neutralization of solid waste.
48. Explain the composting of wood waste.
49. To characterize the ecological system of landfills.

50. Explain the principles of the installation of landfills.
51. To characterize the sanitary rules for the installation of landfills.
52. Characterize the main work in the operation of garbage chutes.
53. Characterize the storage of solid waste.
54. To characterize the environmental aspects of solid waste disposal.
55. Explain the development of systems for collecting solid waste.
56. Explain anti-filtration measures in the arrangement of landfills.
57. Explain the main processes in the transition zone of the landfill.
58. To characterize the main aspects of the problem of solid waste,
59. Explain the biogas collection system.
60. Explain the collection of solid waste.
61. To characterize the device and operation of equipment for the collection of solid waste.
62. Characterize solid waste in the processes of human activity.
63. Characterize the use of transport garbage trucks.
64. Explain the condition and composition of solid waste.
65. Explain the main provisions of the Law of Ukraine "On Waste".
66. Characterize cvd liquid waste.
67. To characterize the existing methods of storage and processing of solid waste.

### **Questions for tests**

#### **MCT 1**

#### **Option number 1**

1. Describe the environmental problems of municipal solid waste.
2. Describe the purpose of portal garbage trucks.
3. Characterize the groups of solid waste by the rate of decomposition. Their half-life.
4. Describe the zoning of the landfill in depth.
5. Characterize the equipment for the collection of solid waste.

#### **Option number 2**

1. Describe the dependence of the morphological composition of solid waste on the level of development of the country.
2. Explain the structure of the garbage chute.
3. Explain the use of transport garbage trucks.
4. To characterize the categories of landfills.
5. Characterize the intensity of anaerobic processes in the body of the landfill over time.

#### **Option number 3**

1. Explain the main work in the operation of garbage chutes.
2. To characterize the block diagram of the landfill.
3. Describe the main processes in the upper aerobic layer of the polygon.
4. Explain the concepts of "young" and "old" filtrates.
5. Explain the environmental aspects of solid waste disposal.

#### **Option number 4**

1. Explain anti-filtration measures in the arrangement of landfills.
2. Describe the main processes in the transition zone of the landfill.
3. Describe the purpose of portal garbage trucks.
4. Characterize the gross yield of solid waste .
5. To characterize the concept of highly loaded landfills.

#### **Option number 5**

1. Explain the main processes in the anaerobic zone of the polygon.
2. Explain the reasons for the formation of filtrates of landfills.
3. To characterize the sanitary rules for the installation of landfills.

4. *Characterize the density of solid waste.*
5. *Describe the gross and separate collection of solid waste .*

**Option number 6**

1. *Explain the classes of waste taken to landfills.*
2. *Describe the queues and complexes of landfills.*
3. *To characterize the first stage of the biodestruction of MSBV.*
4. *Describe the purpose of portal garbage trucks.*
5. *To characterize the environmental aspects of solid waste disposal.*

**Option number 7**

1. *To characterize the ecological system of landfills.*
2. *Characterize the main work in the operation of garbage chutes.*
3. *Explain the gross and separate collection of solid waste.*
4. *Characterize the use of transport garbage trucks.*
5. *Characterize the equipment for the collection of solid waste.*

**Option number 8**

1. *Characterize solid waste in the processes of human activity.*
2. *Explain the condition and composition of solid waste.*
3. *Explain the principles of the installation of landfills.*
4. *To characterize the sanitary rules for the installation of landfills.*
5. *Explain the main processes in the transition zone of the landfill.*

**Option number 9**

1. *Describe the environmental problems of municipal solid waste.*
2. *Explain the structure of the garbage chute.*
3. *Describe the main processes in the upper aerobic layer of the polygon.*
4. *To characterize the gross yield of solid waste .*
5. *Describe the change in the humidity of the solid waste in the process of handling them.*

**Option number 10**

1. *Describe the dependence of the morphological composition of solid waste on various factors.*
2. *Describe the purpose of portal garbage trucks.*
3. *To characterize the sanitary rules for the installation of landfills.*
4. *Characterize the main anaerobic processes in the body of the landfill.*
5. *Mechanisms for the collection and accumulation of solid waste.*

**MCT 2**

**Option number 1**

1. *Describe the main directions of food waste disposal.*
2. *Describe the process of agglomeration of plastics.*
3. *To characterize the general aspects of the problem of glass waste.*
4. *Describe the scheme of sewage treatment plants of modern CVD.*
5. *Describe the "2 seconds rule".*

**Option number 2**

1. *Describe the substances that make up food waste.*
2. *Explain the technology of polymer-sand tiles.*
3. *Explain the main directions of glass waste disposal.*
4. *To characterize the state of labeling of packaging materials in Ukraine.*
5. *Characterize the main types of fluidized bed.*

**Option number 3**

1. *Explain the composting of food waste.*
2. *Characterize polymer-sand tiles.*
3. *Describe the main features of the production of containers from glass waste.*
4. *Explain the basic methods of thermal neutralization of solid waste.*
5. *Explain the environmental aspects of direct combustion of solid waste.*

**Option number 4**

1. *Explain the process of vermicomposting food waste.*
2. *Describe the hydrolysis of polymer waste.*
3. *Describe the technology for obtaining tiles from glass waste.*
4. *To characterize the development of incineration in the world.*
5. *Characterize CVD gaseous emissions.*

**Option number 5**

1. *Explain the basics of EM technology.*
2. *Explain polymer waste pyrolysis.*
3. *Explain the process of obtaining foam glass.*
4. *To characterize the main advantages of burning solid waste.*
5. *Describe CVD liquid waste.*

**Option number 6**

1. *Explain the work of the EM container.*
2. *Describe the features of incineration of polymer waste.*
3. *Characterize the use of glass waste in the composition of building materials.*
4. *Describe the main characteristics of the plant "Energy".*
5. *Characterize solid waste CVD.*

**Option number 7**

1. *To characterize the main directions of polymer waste processing.*
2. *To characterize the main directions of solving the problem of polymer waste in different countries.*
3. *Explain the main groups of marking marks for packaging materials.*
4. *Characterize the schematic diagram of the incinerator.*
5. *To characterize the main supertoxicants of the processes of burning solid waste.*

**Option number 8**

1. *To characterize the technological scheme of plastic waste processing.*
2. *Explain the methods of collection and disposal of metal waste.*
3. *Explain the principles of the Dual System of Germany.*
4. *Characterize the different types of grates.*
5. *Explain the problem of heavy metals in solid waste CVD.*

**Option number 9**

1. *Describe the main directions of food waste disposal.*
2. *Explain the technology of polymer-sand tiles.*
3. *Describe the main features of the production of containers from glass waste.*
4. *To characterize the development of incineration in the world.*
5. *Describe CVD liquid waste.*

**Option number 10**

1. *Describe the substances that make up food waste.*
2. *Characterize polymer-sand tiles.*
3. *Describe the technology for obtaining tiles from glass waste.*
4. *To characterize the main advantages of burning solid waste.*
5. *Characterize solid waste CVD.*

***Work program of the discipline (syllabus):***

***Compiled prof., Doctor of Technical Sciences, Radovenchik V.M.***

***Approved by the Department \_\_\_E and PPT\_\_\_ (protocol No. 14 of 8.06.2022)***

***Approved by the FCE Methodical Commission (Protocol No. 10 of 24.06.2022)***