



Waste Utilization and Recuperation
Working program of the discipline (Syllabus)

Details of the discipline

<i>Level of higher education</i>	<i>First (Bachelor's)</i>
<i>Field of knowledge</i>	<i>10 Natural sciences</i>
<i>Speciality</i>	<i>101 Environmental Studies</i>
<i>Educational program</i>	<i>Environmental safety</i>
<i>Discipline status</i>	<i>Required</i>
<i>Form of study</i>	<i>full-time/full-time (accelerated)/remote/mixed</i>
<i>Year of preparation, semester</i>	<i>3 nd year, spring semester</i>
<i>Scope of discipline</i>	<i>4 ECTS credits (120 hours)</i>
<i>Semester control/ control measures</i>	<i>Exam writing</i>
<i>Schedule of classes</i>	<i>3 hours a week (2 hours of lectures, 1 hour of practical classes)</i>
<i>Language of instruction</i>	<i>Ukrainian</i>
<i>Information about to the eminent course / teachers</i>	<i>Lecturer: https://eco-paper.kpi.ua/prokafedru/vykladachi/vizytky/radovenchik-vyacheslav-mikhajlovich.html;</i> <i>Practical /Laboratory: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/radovenchik-vyacheslav-mikhajlovich.html;</i>
<i>Course placement</i>	<i>https://do.ipk.kpi.ua/course/view.php?id=2782</i>

The program of the discipline

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

The current level of development of society requires the adoption of urgent measures to solve the problem of waste generated in the processes of life and industrial production. This category in our course will include solid waste generated in everyday life and solid waste generated at different stages of industrial production. Today, solid waste disposal reaches the level of a global environmental problem and requires an urgent solution. As in other branches of human activity, there is an extremely diverse approach to solving existing problems. Thus, Sweden today disposes of only 4% of all solid household waste, the rest is recycled or burned with electricity and heat. Due to the incineration of solid household waste in Sweden, 20% of centralized heating of houses is provided. Now the Swedes plan to import more than 800 thousand tons annually. Tons of waste from neighboring countries, as there are not enough of their own. At the same time, experts from the Swedish Environmental Protection Agency believe that this level of waste recycling is only a temporary measure. The main activity in this area is the reduction of the volume of waste generated and the mass implementation of recycling processes of various components that can be removed from the solid waste stream.

The subject of the discipline "Waste Utilization and Recuperation" is the implementation of technical and technological approaches that guarantee stable and safe protection of mankind from the negative effects of solid 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 Utilization and Recuperation». The purpose of studying this discipline is to form in the bachelors a set of knowledge in the field of modern technologies for the collection, transportation, processing and disposal of solid waste, scientific developments in the field of improving 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 methods and technologies of solid waste management, creation of effective systems for their disposal and storage.

In accordance with the goal, the preparation of bachelors in this specialty requires the formation of competencies:

- The ability to assess the impact of technogenesis processes on the state of the environment and to identify environmental risks associated with production activities. **C18.**
- The ability to participate in the development of a management system and handling of production and consumption waste. **C22.**
- The ability to master international and domestic experience in solving regional and cross-border environmental problems. **C25.**
- The ability to distinguish the technological processes of production, to determine the sources and ways of entering the natural environment of harmful components, to assess their impact on human health and the quality of the environment. **C31.**

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

- To use the management principles on which the environmental safety system is based. **PO04.**
- To solve problems in the field of environmental protection using generally accepted and / or standard approaches and international and national experience. **PO07.**
- To be able to predict the impact of technological processes and industries on the environment. **PO11.**
- To participate in the development and implementation of projects aimed at optimal management and treatment of industrial and municipal waste. **PO12.**
- To be able to explain the social, economic and political consequences of implementing environmental projects. **PO15.**
- To demonstrate skills in implementing environmental measures and projects. **PO23.**
- To develop technologies, to use processes and devices that ensure efficient separation, concentration, removal, destruction of harmful impurities in water systems and gas medium, processing and disposal of waste. **PO31.**

2. Pre-requisitions 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 Utilization and Recuperation*" is based on the study of the discipline "*Rationing of anthropogenic load on the environment*". Discipline "*Waste Utilization and Recuperation*" provides the study and assimilation of the discipline "*Technoecology*".

3. The content of the discipline

Section 1. Solid waste in Ukraine.

Basic terms and concepts. Classifications of solid waste. State classifier of waste. Basic technological processes and apparatus for solid waste disposal.

Section 2. Methods to reduce the size of pieces and particles of solid waste.

The concept of grinding and grinding. The main methods of grinding. Solid waste grinding schemes. Classification of devices for grinding waste. The structure and principle of operation of the cheek crusher. The structure and principle of operation of the cone crusher. The structure of the roller shredder. Use of disintegrators and dismembrators. Classification of devices and basic schemes of grinding of solid waste. The structure of the drum mill. Roller-ring and vibrating mills.

Section 3. Methods of classification and sorting.

The concepts of classification and sorting. The essence and effectiveness of sifting processes. Basic sifting schemes. Classification of sifters. Drum sifter. Vibration (inertial) sifters. The principle of operation of the grace sifter. Air separation. Chamber-type air separators. Centrifugal separators. Air-pass separators. Air circulation separators. Cascade-gravity separators. Hydraulic separation. Spiral, rail and bowl classifiers. Structure and efficiency of hydro cyclones. Electrical separation and devices for its implementation.

Section 4. Increase the size of pieces of solid waste.

The need to increase the size of pieces of solid waste. Granulation and devices for its implementation. Download and pressing processes. Briquetting and its main schemes. Baling. High-temperature agglomeration.

Section 5. Enrichment processes.

The need for solid waste enrichment. Gravitational enrichment methods. Jigging processes and devices for their implementation. Enrichment in heavy liquids and suspensions. Enrichment in streams on inclined surfaces. Flushing. Classification of flotation methods. Magnetic separation. Magnetic and electrodynamic separators.

Section 6. Methods of thermal waste processing.

The essence of thermal processing. Burning. Pyrolysis and its benefits. Features of gasification. Fire and plasma neutralization of solid waste. Use of the Vanyukov furnace for solid waste disposal.

Section 7. Biological methods of solid waste processing.

The peculiarity of biological methods of solid waste processing. Composting and basic methods of its implementation. Anaerobic digestion and optimal conditions for its use. Vermicultivation as a process of solid waste processing.

Section 8. Methods of leaching and crystallization of solid waste.

The essence of leaching processes. Basic leaching schemes. Direct-flow and anti-precise leaching methods. Leaching in a fixed layer. Heap leaching. Bacterial leaching. Isohydric and isothermal crystallization. Crystallization by casting. Crystallization as a result of a chemical reaction.

4. Learning materials and resources

4.1. Basic

1. Radovenchyk V.M., Gomelya M.D., Radovenchyk Y.V. *Recycling and recovery of waste / Textbook*. – Kyiv: Condor, 2021. – 246 p.
2. Radovenchyk V.M., Gomel M.D. *Solid waste: collection, processing, warehousing*. – K.: Condor, 2010. – 549 p.
3. *Law of Ukraine "On Waste"*, No. 187/98 – Verkhovna Rada of March 5, 1998
4. *Industrial Ecology / V.L. Filypchuk, M.O. Klymenko, K.K. Tkachuk, S.B. Protsenko, V.M. Radovenchyk, I.I. Zaleskits / : Textbook*. – Rivne: NUWGP, 2013. – 494 p.
5. Orfanova M. M. *Disposal and recovery of waste [Text]: lecture notes / M. M. Orfanova – Ivano-Frankivsk : IFNTUOG, 2010. – 100 p.*
6. DBN V.2.4. – 2005. *Solid waste landfills*.

4.2. Auxiliary

7. *State Classifier of Waste*. – Ukrmetstandard, Kyiv – 1996. – 36 p.
8. *Disposal and recovery of waste. Recycling of waste of pulp and paper production [Electronic resource] : a textbook for applicants for a bachelor's degree in the specialty 161 "Chemical Technologies and Engineering" / V.V. Galish, V.M. Radovenchyk, Y.V. Radovenchyk, M.D. Gomel ; Igor Sikorsky Kyiv Polytechnic Institute*. – Electronic text data (1 file: 9.32 MB). – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2021. – 75 p.
9. *Technogenic deposits – a new unconventional source of mineral raw materials in Ukraine / L.S. Galetsky, U.Z. Naumenko, A.D. Pylypchuk, R.F. Polskoy*. – <http://www.sustainable-cities.net.ua> . – 2005.
10. DSanPiN 2.2.7.029-99 - "Hygienic requirements for the management of industrial waste and determination of their class of danger to public health." Resolution of the Chief State Sanitary Doctor of Ukraine dated 01.07.1999 N 29.
11. DBN V.2.4-4: 2010 *Landfills for the disposal and disposal of toxic waste*. Minregionstroy of Ukraine, 2010. – 56 p.

Information resources on the Internet

1. [Ministry of Environmental Protection and Natural Resources of Ukraine - https://mepr.gov.ua/](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. *State Statistics Service of Ukraine – <http://www.ukrstat.gov.ua/>*
5. *State Agency on Energy Efficiency and Energy Saving of Ukraine - <https://sae.gov.ua/uk/ae>.*
6. *The State Service of Ukraine on Food Safety and Consumer Protection – <https://dpss.gov.ua/>*

5. Methods of mastering the discipline (educational component)

Lectures

Lectures are aimed at:

- providing modern, holistic, interdependent knowledge of the discipline " **Waste Utilization and Recuperation** ", 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;
- determination of the current level of development of science in the field of solid 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.

No s/n	Title of the lecture topic and list of main questions (list of didactic means, references to literature and tasks for IWS)	Hours
1	<p><u>Solid waste in Ukraine.</u> Basic terms and concepts. Classification of solid waste. Literature: 1 [8-20], 3, 4 [286-296]. The task for the IWS is the Law of Ukraine "On Waste".</p>	<u>2</u>
2	<p><u>Legislation of Ukraine in the field of waste management.</u> Accumulated volumes and the level of solid waste utilization in Ukraine. Literature: 1 [20-28], 4 [296-303]. The task for the IWS is waste classification systems of the European Union and Russia. Classes of waste according to the classifiers of different countries.</p>	<u>2</u>
3	<p><u>Methods to reduce the size of pieces and particles of solid waste.</u> Cutting pieces of solid waste. The main types of equipment for cutting. Literature: 1 [29-40]. Tasks on the IWS. The need to grind pieces of solid waste. Utilization of solid waste of pulp and paper industries.</p>	<u>2</u>
4	<p><u>Methods to reduce the size of pieces and particles of solid waste.</u> The concept of grinding and grinding. The main methods of grinding. Solid waste grinding schemes. Classification of devices for grinding waste. The structure and principle of operation of the cheek crusher. The structure and principle of operation of the cone crusher. The structure of the roller shredder. Use of disintegrators and dismembrators. Literature: 1 [40-57], 2 [22-31]. Tasks on the IWS. Solid industrial waste, its basic properties, collection and</p>	<u>4</u>

	storage.	
5	<p><u>Methods to reduce the size of pieces and particles of solid waste.</u> Classification of devices and basic schemes of grinding of solid waste. The structure of the drum mill. Roller-ring and vibrating mills. Literature: 1 [57-68], 2 [31-37]. Tasks on the IWS. Explosive and other methods of grinding waste. Grinding used car tires.</p>	<u>2</u>
6	<p><u>Methods of classification and sorting.</u> The concepts of classification and sorting. The essence and effectiveness of sifting processes. Basic sifting schemes. Classification of sifters. Drum sifter. Vibration (inertial) sifters. The principle of operation of the grace sifter. Literature: 1 [81-91-], 2 [37-44]. Tasks on the IWS. Types of sieves for sifters, their structure and classification.</p>	<u>2</u>
7	<p><u>Methods of classification and sorting.</u> Air separation. Chamber-type air separators. Centrifugal separators. Air-pass separators. Air circulation separators. Cascade-gravity separators. Literature: 1 [91-96], 2 [44-47]. Tasks on the IWS. Utilization of solid waste of the mining and metallurgical complex.</p>	<u>2</u>
8	<p><u>Methods of classification and sorting.</u> Hydraulic separation. Spiral, rail and bowl classifiers. The structure and efficiency of hydrocyclones. Electrical separation and devices for its implementation. Literature: 1 [96-105], 2 [48-55]. Tasks on the IWS. Utilization of solid waste of the fuel and energy complex.</p>	<u>2</u>
9	<p><u>Increase the size of pieces of solid waste.</u> The need to increase the size of pieces of solid waste. Granulation and devices for its implementation. Download and pressing processes. Literature: 1 [106-123], 2 [55-59]. Tasks on the IWS. Granulation and briquetting of wood waste and shavings.</p>	<u>2</u>
10	<p><u>Increase the size of pieces of solid waste.</u> Briquetting and its main schemes. Literature: 1 [123-130], 2 [59-62]. Tasks on the IWS. Utilization of solid waste woodworking and forestry complex.</p>	<u>2</u>
11	<p><u>Increase the size of pieces of solid waste.</u> Baling. High-temperature agglomeration. Literature: 1 [130-139], 2 [63-64-]. Tasks on the IWS. Disposal of solid waste of the machine-building complex.</p>	<u>2</u>
12	<p><u>Enrichment processes.</u> The need for solid waste enrichment. Gravitational enrichment methods. Jigging processes and devices for their implementation. Enrichment in heavy liquids and suspensions. Enrichment in streams on inclined surfaces. Literature: 1 [140-144], 2 [64-68]. Tasks on the IWS. Utilization of solid waste of the mining and metallurgical complex.</p>	<u>2</u>

13	<p><u>Enrichment processes.</u> Classification of flotation methods. Magnetic separation. Magnetic and electrodynamic separators. Literature: 1 [144-153], 2 [68-75]. Tasks on the IWS. Utilization of solid waste of the mining and metallurgical complex.</p>	<u>2</u>
14	<p><u>Methods of thermal waste processing.</u> The essence of thermal processing. Burning. Pyrolysis and its benefits. Literature: 1 [155-174], 2 [75-78]. Tasks on the IWS. Utilization of solid waste woodworking and forestry complex.</p>	<u>2</u>
15	<p><u>Methods of thermal waste processing.</u> Features of gasification. Fire and plasma neutralization of solid waste. Use of the Vanyukov furnace for solid waste disposal. Literature: 1 [175-188], 2 [78-81]. Tasks on the IWS. Disposal of solid waste of the transport complex.</p>	<u>2</u>
16	<p><u>Biological methods of solid waste processing.</u> Peculiarity of biological methods of solid waste processing. Composting and basic methods of its implementation. Anaerobic digestion and optimal conditions for its use. Vermicultivation as a process of solid waste processing. Literature: 1 [189-227], 2 [86-88]. Tasks on the IWS. Utilization of solid agricultural waste.</p>	<u>2</u>
17	<p><u>Methods of leaching and crystallization of solid waste.</u> The essence of leaching processes. Basic leaching schemes. Direct-flow and anti-precise leaching methods. Leaching in a fixed layer. Heap leaching. Bacterial leaching. Isohydric and isothermal crystallization. Crystallization by casting. Crystallization as a result of a chemical reaction. Literature: 1 [229-237], 2 [81-86]. Tasks on the IWS. Disposal of solid waste of the chemical industry.</p>	<u>2</u>
18	Total – 36 hours	36

Practical classes

In the system of professional training of students, practical classes occupy 33% of the classroom load. Being an addition to the lecture course, they lay and form the foundations of the bachelor's qualification in ecology. The content of these classes and the methods of their conduct ensure the development of the creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow you to test knowledge, in connection with which this type of work is an important means of operational feedback. Therefore, practical classes perform not only cognitive and educational functions, but also contribute to the growth of students as creative workers in the field of ecology.

The main objectives of the cycle of practical classes:

- ◆ help students systematize, consolidate and deepen theoretical knowledge in the field of waste management;
- ◆ teach students techniques for solving practical problems, promote mastery of skills and abilities to perform calculations, graphic and other types of tasks;
- ◆ teach them to work with scientific and reference literature, documentation 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 IWS)	Hours
1	Geosynthetic materials and their classification (2 hours). Literature: 2. pp. 88-96. The task at the IWS is to prepare a presentation of one of the companies engaged in the production or sale of geosynthetic materials. [2 c. 88].	2
2	Geosynthetic clay machines (2 hours). Literature: 2. pp. 97-99. The task of the IWS is to analyze the order of prices for geosynthetic materials on the territory of Ukraine [2 p. 88].	2
3	Geomembranes. Technologies of installation of geosynthetic materials (4 hours). Literature: 2. pp. 99-108. Task on IWS – To give examples of storages using geosynthetic materials [2 p. 107-108].	4
4	Solid industrial waste storage facilities (4 hours). Literature: 1. pp. 117-130; 10; 11. The task at the IWS is to assess the trends in the volume of industrial waste storage facilities in Ukraine [2 p. 109-114].	4
5	The concept of man-made deposits, their volumes and distribution in Ukraine. (4 hours). Literature: 1. pp. 362-384; 10. The task at the IWS is to analyze the composition of man-made deposits of Ukraine in terms of the possibility of extracting secondary resources [2 c. 115-116; 9; 10].	4
6	Modular control work	2
	Just	18

1. Independent work of the student

Independent work of students takes 55% of the time to study the credit module. The main task of independent work of students is to master scientific knowledge in the field of new processes of disposal and disposal of waste that are not included in the list of lecture issues, 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 analyze the possibilities of migration and transformation of substances formed during the storage, transportation and processing of waste of various origins in the environment, and based on the analysis of the processed information, to come to their own reasonable conclusions on the choice of acceptable technology.

No s/n	The name of the topic submitted for independent study	Number of hours of IWS
Section 1. Solid waste in Ukraine.		

1	<i>Law of Ukraine "On Waste". Waste classification systems of the European Union and Russia. Waste classes according to the classifiers of different countries. Their difference and common. Literature: 1 [-], 3, 7.</i>	4
<i>Section 2. Methods to reduce the size of pieces and particles of solid waste.</i>		
2	<i>The need to grind pieces of solid waste. Utilization of solid waste of pulp and paper industries. Solid industrial waste, its basic properties, collection and storage. Explosive and other methods of grinding waste. Grinding used car tires. Literature: 1 [29-30], 8 [71-74], 2 [36-37], 2 [209-228].</i>	4
<i>Section 3. Methods of classification and sorting.</i>		
3	<i>Types of sieves for sifters, their structure and classification. Utilization of solid waste of the mining and metallurgical complex. Utilization of solid waste of the fuel and energy complex. Literature: 1 [81-84], 2 [133-142], 2 [142-153].</i>	4
<i>Section 4. Increase the size of pieces of solid waste.</i>		
4	<i>Granulation and briquetting of wood waste and shavings. Utilization of solid waste woodworking and forestry complex. Disposal of solid waste of the machine-building complex. Literature: 2 [239-245-], 2 [231-2- 57], 2 [173- 200].</i>	4
<i>Section 5. Enrichment processes.</i>		
5	<i>Utilization of solid waste of the mining and metallurgical complex. Literature: 2 [133-142-].</i>	4
<i>Section 6. Methods of thermal waste processing.</i>		
6	<i>Utilization of solid waste woodworking and forestry complex. Literature: 2 [231-257-].</i>	4
<i>Section 7. Biological methods of solid waste processing.</i>		
7	<i>Solid waste disposal of agriculture. Literature: 2 [269-288].</i>	4
<i>Section 8. Methods of leaching and crystallization of solid waste.</i>		
8	<i>Disposal of solid waste of the chemical industry. Literature: 2 [153-173].</i>	4
9	<i>Preparation for a modular test</i>	4
10	<i>Exam</i>	30
	Total hours	66

Policy and control

2. 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://www.shortcoursesportal.com/studies/297793/environmental-waste-management.html?ref=search_card.

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

Deadlines and Rescheduling Policy

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 <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 <https://kpi.ua/code>".

3. Types of control and rating system for evaluating learning outcomes (RSOs)

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

Semester	School time		Distribution of training hours				Control measures		
	Loans	acad. H.	Lecture	Practical	Lab. Rob.	IWS	MCT	HCW	Semester control
6	4	120	36	18		66	1		Exam

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

The rating of a student from a credit module consists of points that he receives for:

1. student's answers at lectures during express control;
2. two tests (MCT is divided into 2 works lasting 45 minutes each),
3. performance of practical work,
4. answer to the exam.

The system of rating (weight) points and evaluation criterion:

1. Express control at lectures:

Weight score –4.

The maximum number of points when interviewing at a lecture of at least 7 students is $7 \times 4 = 28$ points

Criteria for assessing students' knowledge:

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

2. Module control.

Weight score – 10. The maximum number of points for all tests is: 10 points x 2 works = 20 points

Criteria for evaluating tests

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

3. Work in practical classes.

Weight score – 3. The maximum number of points in all practical works is: 3 points x 4 p / p = 12 points

Criteria for assessing students' knowledge:

Completeness and signs of response	Points
Clear and timely execution and design of work	3
Mistakes have been made in the work that distort the result	2
Late execution of work, deficiencies in the design	1
Failure to do practical work	0

Thus, the rating semester scale from the credit module is:

$$R_C=28+20+12=60 \text{ points}$$

The exam component is 40% of R:

$$R_{ex}=40 \text{ points.}$$

Thus, the rating scale from the credit module is:

$$R=R_C+R_{EZ}=60+40=100 \text{ points}$$

The maximum amount of points of the starting component is 60 points. A prerequisite for admission to the exam is the fulfillment of the discipline plan and the starting rating of at least 36 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.

The component of the examination scale is 40% of R:

$$R_{ex} = 40 \text{ points.}$$

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:

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

The sum of the starting points and points for the examination test is transferred to the examination mark according to the table.

Points $R = R_C + R_{ECC}$	ECTS score	Examination grade
95-100	A	Perfectly
85-94	B	well
75-84	C	well
65-74	D	Satisfactory
60-64	E	Satisfactory
Less than 60	Fx	Disappointing
Unaccounted for laboratory work or $R_C < 34$	F	not allowed

4. Additional information on the discipline (educational component)

An approximate list of questions that are submitted for semester control

1. Explain the basic terms and concepts.
2. Give classifications of solid waste.
3. Describe the State Waste Classifier.
4. List the main technological processes and devices for solid waste disposal.
5. Define and explain the concepts of grinding and grinding.
6. Describe the main grinding methods.
7. Provide schemes for grinding solid waste.
8. Classify waste shredding machines.
9. Describe the structure and principle of operation of the cheek crusher.
10. Describe the structure and principle of operation of the cone crusher.

11. Describe the structure of the roller shredder.
12. Describe the use of disintegrators and dismembrators.
13. Classify the apparatuses and basic schemes for grinding solid waste.
14. Describe the structure of the drum mill.
15. Describe the roller-ring and vibrating mills.
16. Explain the concepts of classification and sorting.
17. Describe the essence and effectiveness of sifting processes.
18. Provide basic sifting schemes.
19. Give a classification of sifters.
20. Describe the drum sifter.
21. Describe the vibration (inertial) sifters.
22. Describe the principle of operation of the grace sifter.
23. Describe the air separation.
24. Describe the chamber-type air separators.
25. Describe centrifugal separators.
26. Describe the air-passing separators.
27. Describe the air circulation separators.
28. Describe the cascade-gravity separators.
29. Explain hydraulic separation.
30. List the spiral, rail and bowl classifiers.
31. Describe the structure and efficiency of hydrocyclones.
32. Describe the electrical separation and devices for its implementation.
33. Describe the need to increase the size of pieces of solid waste.
34. Describe the granulation and devices for its implementation.
35. Cite the download and pressing processes.
36. Define and explain briquetting and its main schemes.
37. Define and explain the baling.
38. Describe the high-temperature agglomeration.
39. Describe the need for solid waste enrichment.
40. Describe gravitational enrichment methods.
41. Define and explain the jigging processes and apparatuses for their implementation.
42. Describe the enrichment in heavy liquids and suspensions.
43. Describe enrichment in streams on inclined surfaces.
44. Define and explain the flushing.
45. Classify flotation methods.
46. Define and explain magnetic separation.
47. Describe magnetic and electrodynamic separators.
48. Describe the essence of thermal processing.
49. Define and explain the burning.
50. Define and explain the pyrolysis and its benefits.
51. Describe the features of gasification.
52. Describe the fire and plasma neutralization of solid waste.
53. Describe the use of the Vanyukov furnace for solid waste disposal.
54. Describe the essence of leaching processes.
55. Give basic leaching schemes.
56. Describe direct-flow and countercurrent leaching methods.
57. Describe leaching in a fixed layer.
58. Define and explain the lump leaching.
59. Define and explain the bacterial leaching.

60. Define and explain isohydric and isothermal crystallizations.
61. Define and explain crystallization by casting.
62. Describe crystallization as a result of a chemical reaction.
63. Describe the peculiarity of biological methods of solid waste processing.
64. Describe composting and the main methods of its implementation.
65. Describe anaerobic digestion and optimal conditions for its use.
66. Describe vermicultivation as a solid waste recycling process.
67. Classify geosynthetic materials.
68. Describe the structure and characteristics of the main types of geomaterials.
69. Cite the technologies of installation of geosynthetic materials.
70. Describe solid waste storage facilities using geosynthetic materials.

Questions for tests

MKR 1

№1

1. Give classifications of solid waste.
2. Classify waste shredding machines.
3. Describe the structure of the drum mill.
4. Describe the fire method of cutting metals.
5. Describe the technology of mechanical grinding of tires.

№2

1. Describe the State Waste Classifier.
2. Describe the structure and principle of operation of the cheek crusher.
3. Describe the equipment for fire cutting of metals.
4. Describe the barodestructional tire recycling technology.
5. Describe the products obtained after grinding tires and their use

№3

1. List the main technological processes and devices for solid waste disposal.
2. Describe the structure and principle of operation of the cone crusher.
3. Describe the essence of mechanical cutting of waste.
4. Describe the principle of cryogenic method of grinding tires.
5. Describe the equipment for grinding building structures.

№4

1. Define and explain the concepts of grinding and grinding.
2. Describe the structure of the roller shredder.
3. Describe the mechanical cutting equipment
4. Describe the explosion-circulation method of grinding tires.
5. Describe the use of tire grinding products.

№5

1. Describe the main grinding methods.
2. Describe the use of disintegrators and dismembrators.
3. Describe the main types of pollen for cutting pieces of waste.
4. Describe the technology for grinding tires using ozone.
5. Give classifications of solid waste.

№6

1. Provide schemes for grinding solid waste.
2. Classify the apparatuses and basic schemes for grinding solid waste.
3. Describe the roller-ring and vibrating mills.
4. Describe barodestructional tire recycling.
5. Describe cryogenic, high-temperature and explosive methods of metal grinding.

MKR 2

№1

1. Briefly describe the main methods of classification and sorting.
2. Air-passage and air-circulation separators.
3. Processes of triboelectrostatics and pyroelectrization.
4. Describe the work of the fluidized bed granulator.
5. Describe the technology for obtaining wood briquettes.

№2

1. Describe the main types of sieves, their structure and designations.
2. Describe the structure and principle of operation of the cascade-gravitational separator.
3. Describe the drum electrostatic separator.
4. Describe the packaging of metal waste.
5. Describe the process of high-temperature agglomeration.

№3

1. Describe the main sifting schemes, their advantages and disadvantages.
2. Describe the structure and principle of operation of the spiral classifier.
3. Describe the chamber electrostatic separator.
4. Describe the briquetting process and its schemes.
5. Describe the benefits of wood pellets.

№4

1. The principle of operation and structure of the drum sift.
2. Describe the structure and principle of operation of the rail and chash classifiers.
3. Justify the need to increase the size of pieces of solid waste.
4. Describe the general provisions for granulation of wood waste.
5. Describe the process of high-temperature agglomeration.

№5

1. Describe the structure and characteristics of vibration sifters.
2. Hydrocyclones, their structure and features.
3. Work of drum granulators.
4. Describe the technology for obtaining wood pellets.
5. Give the basic requirements for raw materials for the production of wood pellets.

№6

1. Chamber air separators.
2. Classify electrical separation devices and describe the principle of their operation.
3. Describe the operation of the roller press and matrix press.
4. Advantages of wood pellets and briquettes over other energy carriers.
5. Describe the main aspects of the method of electrical separation.

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)