



The National Technical University  
of Ukraine "Igor Sikorsky Kyiv Polytechnic  
Institute"



Department of Ecology and  
Plant Polymers Technology

## Waste Utilization and Recuperation Work program of the discipline (Syllabus)

### Details of the discipline

Level of higher education	<i>First (Bachelor's)</i>
Branch of knowledge	<i>16 Chemical and bioengineering</i>
Speciality	<i>161 Chemical technology and engineering</i>
Educational program	<i>Industrial ecology and resource efficient cleaner technologies</i>
Status of discipline	<i>Required</i>
Form of training	<i>full-time(day)/evening(evening)/part-time/remote/mixed</i>
Year of preparation, semester	<i>3rd year, spring semester</i>
Volume of discipline	<i>4 (120)</i>
Semester control/control measures	<i>Written exam</i>
Schedule of classes	<i>3 hours per week (2 hours of lectures, 1 hour of practical classes)</i>
Language of instruction	<i>Ukrainian</i>
Information about the course /teachers	Lecturer and: <a href="https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyk/radovenchik-vyacheslav-mikhajlovich.html">https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyk/radovenchik-vyacheslav-mikhajlovich.html</a> ; Practical /Laboratory: <a href="https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyk/radovenchik-vyacheslav-mikhajlovich.html">https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytyk/radovenchik-vyacheslav-mikhajlovich.html</a> ;
Course placement	<a href="https://do.ipk.kpi.ua/course/view.php?id=2782">https://do.ipk.kpi.ua/course/view.php?id=2782</a>

### Program of discipline

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

The current level of development of society requires the adoption of urgent measures to solve the problem of waste that is formed 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 areas of human activity, there is an extremely diverse approach to solving existing problems. Sweden today buries only 4% of all solid household waste, the rest is recycled or burned with electricity and heat. That this level of waste processing is only a temporary measure. The main activity in this area is the reduction of the volume of waste generated and the mass introduction 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 humanity from the negative impact 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 environmental safety management institutions of the state, scientific institutions and organizations, enterprises.**

In order to successfully solve the problems of environmental protection and preservation while ensuring the stable development of mankind, specialists should be free to have information, be able to solve complex problems of environmental protection 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 the formation of a complex of knowledge in the field of modern technologies for collecting,

transporting, processing and burying solid waste, scientific developments in the field of improving the efficiency of using natural material and energy resources, a set of skills and skills necessary for the introduction into production and management of modern and new products. We method and technology pits solid waste management, creating effective systems for their disposal and storage.

In accordance with the purpose of training masters in this area requires forms of competence:

- The desire to preserve the environment. **C06.**
- 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. **C21.**
- The ability to design and implement technologies for purification and processing of exhaust gases, wastewater and solid waste. **C22.**

In accordance with the requirements of the program of the discipline "**Waste Utilization and Recuperation**", students after its assimilation must demonstrate the following programmatic learning results:

- To develop and implement projects related to chemical production technologies and equipment, taking into account objectives, resources, existing constraints, social and economic aspects and risks. **PO05.**
- To participate in the development and implementation of projects aimed at optimal management and treatment of industrial waste. **PO17.**

## **2. Prerequisite and requisition disciplines (place in the structural and logical scheme of training according to the relevant educational program)**

The study of the discipline "**Waste Utilization and Recuperation**" is based on the principles of integration of various knowledge gained by students during the bakalavrat in the study of the disciplines of natural and engineering-technical direction, provided by the discipline "Industrial Ecology". The discipline "**Waste Utilization and Recuperation**" is a fundamental basis that should ensure the solution of complex problems in the field of environmental protection at the price of the environment, rational use of natural resources and is aimed at a deep rethinking of existing and creation of new holistic knowledge and professional practice in the field of ensuring sustainable development of agriculture and provides the study of the disciplines "Ecological safety of production" and "KP on technologies and design of industry industries".

## **3. Contents of the discipline**

### **Section 1. Solid waste in Ukraine.**

Basic terms and concepts. Classification of solid waste. The main technological processes and apparatuses for the disposal of solid waste.

### **Section 2. Methods for reducing the size of pieces and particles of solid waste.**

Cutting pieces of solid waste. The concept of grinding and grinding. Schemes of grinding of solid waste. Classification of devices for grinding waste. Structure and principle of operation of the cheek crusher.

### **Section 3. Methods of classification and sorting.**

The concept of classification and sorting. The essence and effectiveness of sifting processes. The main sifting schemes. Classification of sieves. Drum sieve. Vibration (inertial) sifting. The principle of operation of the grace sieve. Air separation. Air separators of chamber type. Centrifuge separators. Air-passing separators. Air-circulating separators. Cascading-gravitational separators. Hydraulic separation. Spiral, rail and bowl classifiers. 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. Tugging. High-temperature agglomeration.*

#### **Section 5. Processes of enrichment.**

*The need to enrich solid waste. Gravitational methods of enrichment. 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 advantages. Features of gasification. Fire and plasma disposal of solid waste. Use vanyukov furnace to neutralize solid waste.*

#### **Section 7. Biological methods of solid waste processing.**

*The peculiarity of biological methods of solid waste processing. Composting and the main methods of its implementation. Anaerobic fermentation 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. The main leaching schemes. Direct and against precise leaching methods. Leaching in a fixed layer. Cue leaching. Bacterial leaching. Isogydric and isothermal crystallization. Crystallization by planting. Crystallization as a result of a chemical reaction.*

### **4. Educational materials and resources**

#### **4.1. Basic**

1. Radovenchyk V. M., Gomel M. D., Radovenchyk Y. V. *Disposal and recovery of waste / Textbook.* – Kyiv: Condor, 2021. – 246 p.
2. Radovenchik 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. Filipchuk, M. O. Klymenko, K. K. Tkachuk, S. B. Protsenko, V. M. Radovenchik, I. I. Zaleskitz / : Teaching manual.* – Rivne: NUWGP, 2013. – 494 p.
5. Orfanov M. M. *Disposal and recovery of waste [Text]: lecture summary / M. M. Orfanov – Ivano-Frankivsk: IFNTUOG, 2010.* – 100 p.
6. *DBN V.2.4. – 2005. Landfills of solid domestic waste. Basics of design.* – K., 2006. – 35 p.

#### **4.2. Auxiliary**

7. *State classifier of waste.* – Ukrmetstandart, Kyiv – 1996. – 36 p.
8. *Disposal and recovery of waste. Recycling of waste pulp and paper industries [Electronic resource] : textbook for applicants for bachelor's degree in the specialty 161 "Chemical technologies and engineering" / V. V. Galish, V. M. Radovenchik, Y. V. Radovenchik, M. D. Gomel ; KPI them. Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file: 9.32 MB).* – Kyiv: KPI them. Igor Sikorsky Kyiv Polytechnic Institute, 2021. – 75 p.
9. *Technogenic deposits are a new unconventional source of mineral raw materials in Ukraine / L.S. Galetsky, U.Z. Naumenko, A.D. Pylypchuk, R.F.Polska.* – <http://www.sustainable-cities.net.ua>. – 2005.

10. DSanPiN 2.2.7.029-99 - "Hygienic requirements for breeding industrial waste and determining their class of danger to public health". Resolution of the StateSanitary Doctor of Ukraine dated 01.07.1999 No. 29.
11. DBN V.2.4-4:2010 Poligones for neutralization and disposal of toxic waste. Ministry of Regional Development of Ukraine, 2010. – 56 p.

### Information resources on the Internet

1. Ministry of Environmental Protection and Natural Resources of Ukraine - <https://mepr.gov.ua/>
2. Industrial ecology. Community of environmental specialists - <http://www.eco.com.ua/>
3. Professional Association of Ecologists of Ukraine (PAAU) - <https://paeu.com.ua/>
4. State Statistics Service of Ukraine – <http://www.ukrstat.gov.ua/>
5. The State Agency for Energy Efficiency and Energy Saving of Ukraine is <https://sae.gov.ua/uk/ae>.
6. State Food and Consumer Service of Ukraine – <https://dpss.gov.ua/>

## Educational content

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

#### Lecture classes

Lectures are aimed at:

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

No s/p	<b>The name of the topic of the lecture and the list of main issues (list of didactic means, reference to literature and tasks on the IWS)</b>	<b>Hours</b>
1	<p><u>Classification of solid waste.</u> Basic terms and concepts. Classification of solid waste. Legislation of Ukraine in the field of waste management. The volume of accumulated and the level of solid waste disposal in Ukraine. The main technological processes and devices for the disposal of solid waste.</p> <p><b>Literature: 1 [8-2 8], 3, 4 [286-296].</b></p> <p>The task of the IWS is the Law of Ukraine "On Waste". Waste classification systems of the European Union and Russia. Waste classes according to the classifiers of different countries.</p>	<u>0,5</u>
2	<p><u>Methods for reducing the size of pieces and particles of solid waste.</u> Cutting pieces of solid waste. The main type and equipment for cutting. The concept of grinding and grinding. Schemes of grinding of solid waste. Classification of devices for grinding waste. Structure and principle of operation of the cheek crusher.</p>	<u>1</u>



	<p><b>Literature: 1 [2 9-68], 2 [2 2-3 7].</b>  <i>Tasks on the IWS: The need to grind a piece of solid waste. Disposal of solid waste pulp and paper industries. Solid industrial waste, its main properties, collection and warehousing. Explosive and other methods of grinding waste. grinding used car tires.</i></p>	
3	<p><u>Methods of classification and sorting.</u>  <i>The concept of classification and sorting. The essence and effectiveness of sifting processes. The main sifting schemes. Classification of sieves. Drum sieve. Vibration (inertial) sifting. The principle of operation of the grace sieve. Air separation. Air separators of chamber type. Centrifuge separators. Air-passing separators. Air-circulating separators. Cascading-gravitational separators. Hydraulic separation. Spiral, rail and bowl classifiers.</i>  <b>Literature: 1 [81-105], 2 [37-55].</b>  <i>Tasks on the IWS. Types of sieves for sieves, their structure and classification.</i></p>	0,5
4	<p><u>Increase the size of pieces of solid waste.</u>  <i>The need to increase the size of pieces of solid waste. Granulation and devices for its implementation. Download and pressing processes. Briquette and its main schemes.</i>  <b>Literature: 1 [106-1 39], 2 [55-64].</b>  <i>Tasks on the IWS. Granulation and briquetting of wood waste and chips.</i></p>	1
5	<p><u>Processes of enrichment.</u>  <i>The need to enrich solid waste. Gravitational methods of enrichment. Jigging processes and devices for their implementation. Enrichment in heavy liquids and suspensions. Enrichment in streams on inclined surfaces. Classification of flotation methods. Magnetic separation. Magnetic and electrodynamic separators.</i>  <b>Literature: 1 [140-153], 2 [64-75].</b>  <i>Tasks on the IWS. Disposal of solid waste of the mining and metallurgical complex.</i></p>	1
6	<p><u>Methods of thermal waste processing.</u>  <i>The essence of thermal processing. Burning. Pyrolysis and its advantages. Features of gasification. Fire and plasma disposal of solid waste. Use of van Leko furnace to neutralize solid waste.</i>  <b>Literature: 1 [155-188], 2 [75-81].</b>  <i>Tasks on the IWS. Disposal of solid waste of woodworking and forest complex. Disposal of solid waste of the transport complex.</i></p>	0,5
7	<p><u>Biological methods of solid waste processing.</u> <i>The peculiarity of biological methods of solid waste processing. Composting and the main methods of its implementation.</i>  <b>Literature: 1 [189-227], 2 [86-88].</b>  <i>Tasks on the IWS. Disposal of solid agricultural waste.</i></p>	1
8	<p><u>Methods of leaching and crystallization of solid waste.</u>  <i>The essence of leaching processes. The main leaching schemes. Direct and indirect leaching methods. Leaching in a fixed layer. Counter leaching. Bacterial leaching. Isohydric and isothermal crystallization. Crystallization by planting. Crystallization as a result of a chemical reaction.</i>  <b>Literature: 1 [229-237], 2 [81-86].</b>  <i>Tasks on the IWS. Disposal of solid waste chemical industry.</i></p>	0,5
18	Total – 6 hours	6

### Practical classes

*In the system of professional training of students, practical classes are 10 hours. 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 tasks of the cycle of practical classes:*

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

<i>No s/p</i>	<i>The name of the topic of the lesson and the list of main questions (list of didactic support, references to literature and tasks to the IWS)</i>	<i>Hours</i>
1	Geosynthetic materials and their classification (2 hours). <b>Literature: 2 p. 88-96.</b> 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 claymother (2 hours). <b>Literature: 2 p. 97-99.</b> Tasks at the IWS – 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 (2hours) . <b>Literature: 2 p. 99-108.</b> The task of the IWS is to give examples of storages using geosynthetic materials [2 c. 107-108].	2
4	Solid industrial waste storage facilities (2 hours) . <b>Literature: 1. p. 11 7-130; 11; 12.</b> The task at the IWS is to assess the trends in changes in the volume of industrial waste storage facilities on the territory of Ukraine [2 p. 109-114].	2
6	Modular control work (2 hours)	2
	<b>Just</b>	10

## 6. Independent work of the student

The main task of independent work of students is the mastery of scientific knowledge in the field of designing water use systems that are not included in the list of lecture issues, through personal search for information, the formation of an active interest in the creative approach in educational work. substances of both natural and anthropogenic origin in the environment, and on the basis of the analysis of the processed information, come to their own reasonable conclusions.

<i>No s/p</i>	<i>Name of the topic submitted for self-study</i>	<i>Number of hours of IWS</i>
<i>Section 1. Solid waste in Ukraine.</i>		
1	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. <b>Literature: 1 [20-2 6], 3, 7.</b>	9
<i>Section 2. Methods for reducing the size of pieces and particles of solid waste.</i>		
2	The need to grind a piece of solid waste. Disposal of solid waste pulp and paper production. solid industrial waste, their main properties, collection and warehousing. Explosive and other methods of grinding waste. grinding used car tires. <b>Literature: 1 [2 9-30], 8 [71-7 4], 2 [36-37], 2 [209-228].</b>	12
<i>Section 3. Methods of classification and sorting.</i>		

3	<i>Types of sieves for sieves, their structure and classification. Disposal of solid waste of the mining and metallurgical complex. Literature: 1 [81-84], 2 [133-142], 2 [142-153].</i>	10
<i>Section 4. Increase the size of pieces of solid waste.</i>		
4	<i>Granulation and briquetting of wood waste and chips. Disposal of solid waste of woodworking and forest complex. Disposal of solid waste of the machine-building complex. Literature: 2 [239-245], 2 [231-257], 2 [173-200].</i>	11
<i>Section 5. Processes of enrichment.</i>		
5	<i>Disposal of solid waste of the mining and metallurgical complex. Literature: 2 [133-142].</i>	9
<i>Section 6. Methods of thermal waste processing.</i>		
6	<i>Disposal of solid waste of woodworking and forest complex. Literature: 2 [231-257].</i>	9
<i>Section 7. Biological methods of solid waste processing.</i>		
7	<i>Disposal of solid agricultural waste. Literature: 2 [269-288].</i>	7
<i>Section 8. Methods of leaching and crystallization of solid waste.</i>		
8	<i>Disposal of solid waste chemical industry. Literature: 2 [153-173].</i>	7
6	<i>Exam</i>	30
	<b>Total hours</b>	104

## Politics and control

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

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

*Attending classes is a mandatory component of assessment. 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

- *encouraging points can be credited by the teacher only for the performance of creative works in the discipline or additional passage of online specialized courses with the receipt of the appropriate certificate:*
  - <https://welcome.stepik.org/ru/>;
  - <https://prometheus.org.ua/>;
  - <https://www.coursera.org/learn/>;
  - <https://croapaia.com/>;
  - <https://www.shortcoursesportal.com/>.

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

- *penalty points within the discipline are not provided.*

#### Polika deadlines and re-assemblys

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

#### Academic Integrity Policy

*Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the absence of references when using printed and electronic materials, quotes, opinions of other authors. Invalid 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 policies and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>

### **Policy of academic behavior and ethics**

Students should be tolerant, respect the opinion of others, object to formulate in the correct form, constructively maintain feedback in the classroom.

The norms of ethical behavior of students and employees are defined in Section 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 assessing learning outcomes (RCOs)**

Distribution of educational time by types of classes and tasks in the discipline according to 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	6	10		104	1		Exam

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

The student's rating from the credit module consists of points that he receives for:

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

System of rating (weight) points and evaluation criteria:

1. Express control at lectures:

Weight score –4.

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

Criteria for assessing students' knowledge:

<b>Completeness and signs of response</b>	<b>Points</b>
Clear and complete answer to the question	4
Some inaccuracies or errors were made in the answer	3
The answer does not contain the wording of terms, laws and formulas	2... 1
The answer is not counted	0

### 2.Modular control.

Weight point – 10. The maximum number of points for all control works is equal to: 10 points x 2 jobs = 20 points

Criteria for evaluation of control works

<b>Completeness and signs of response</b>	<b>Points</b>
Full answer to all questions	10
Some inaccuracies are made in the answer	8... 9
This partial answer or in answers to questions and mistakes made	6... 7
This fuzzy answer: there are no or made errors in formulas, reactions, terms and definitions	4... 5
Unsatisfactory answers to individual questions and the presence of significant errors from	1... 3



<i>other questions</i>	
<i>Control not counted</i>	<i>0</i>

*3. Work in practical classes.*

*Weight point – 3. The maximum number of points in all practical works is equal to: 3 points x 4 p/p = 12 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>3</i>
<i>In the work made mistakes that distort the result</i>	<i>2</i>
<i>Untimely performance of work, shortcomings in the design</i>	<i>1</i>
<i>Non-fulfillment of practical work</i>	<i>0</i>

*Penalties and incentive points:*

- report on one of the sections of the subject ..... +2... +4 points*
- development of didactic material course .....+2..... +5 points*

*Thus, the rating semester scale of 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 implementation of the discipline plan and the starting rating of at least 36 points.*

*According to the results of educational work for the first 7 weeks, the "ideal student" should score 30 points. At the first certification (8th week), the student receives "enrolled" if his current rating is not less than 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), the student receives "enrolled" if his current rating is not less than 40 points.*

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

*Maximum number of points - 4x10=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 the exam and should increase their rating.*

*A prerequisite for admission to the exam is the implementation of all MCT.*

*Criteria for assessing students' knowledge in the exam:*

<i>Completeness and signs of response</i>	<i>Points</i>
<i>Full answer to the question</i>	<i>10</i>
<i>Some inaccuracies are made in the answer</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: there are no or made errors in formulas, reactions, terms and</i>	<i>4... 5</i>

<i>definitions</i>	
<i>Unsatisfactory answers to individual questions and the presence of significant errors from other questions</i>	<i>1... 3</i>
<i>The answer is not counted</i>	<i>0</i>

The amount of starting points and points for examination control work is transferred to the examination assessment according to the table.

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

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

### Approximate list of questions submitted for semester control

1. Explain the basic terms and concepts.
2. Give classification of solid waste.
3. Describe the State Classifier of Waste.
4. List the main technological processes and devices for the disposal of solid waste.
5. Define and explain the concept of grinding and grinding.
6. Describe the main methods of grinding.
7. Give schemes for grinding solid waste.
8. Classify waste grinding 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 roll shredder.
12. Describe the use of disintegrators and dismembrators.
13. Classify the machines and main schemes of grinding solid waste.
14. Describe the structure of the drum mill.
15. Describe roller-ring and vibration mills.
16. Explain the concept of classification and sorting.
17. Describe the essence and effectiveness of sifting processes.
18. Give the main sifting schemes.
19. Give the classification of sifts.
20. Describe the drum sieve.
21. Describe vibrating (inertial) sifts.
22. Describe the principle of operation of the grace sieve.
23. Describe air separation.
24. Describe chamber-type air separators.
25. Describe the centrifly separators.
26. Describe air-passing separators.
27. Describe air-circulating separators.

28. Describe cascading-gravitational separators.
29. Explain hydraulic separation.
30. List spiral, rail and bowl classifiers.
31. Describe the structure and efficiency of hydrocyclones.
32. Describe electrical separation and devices for its implementation.
33. Describe the need to increase the size of pieces of solid waste.
34. Describe granulation and devices for its implementation.
35. Give download and pressing processes.
36. Define and explain the briquetting and its main schemes.
37. Define and explain the bale.
38. Describe a high-temperature agglomeration.
39. Describe the need to enrich solid waste.
40. Describe the gravitational methods of enrichment.
41. Define and explain the jigging processes and devices for their implementation.
42. Describe 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 heat treatment.
49. Define and explain the burning.
50. Define and explain pyrolysis and its benefits.
51. Describe the features of gasification.
52. Describe fire and plasma disposal of solid waste.
53. Describe the use of Vanyukov furnace to neutralize solid waste.
54. Describe the essence of leaching processes.
55. Describe direct and anti-current leaching methods.
56. Describe leaching in a fixed layer.
57. Define and explain the consolation.
58. Define and explain bacterial leaching.
59. Define and explain isogidrical and isothermal crystallization.
60. Define and explain the crystallization by planting.
61. Describe crystallization as a result of a chemical reaction.
62. Describe the peculiarity of biological methods of solid waste processing.
63. Describe composting and the main methods of its implementation.
64. Describe anaerobic fermentation and optimal conditions for its use.
65. Describe vermicultivation as a process of solid waste processing.

***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)