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

Ecology and Plant polymers technology

Characteristics of water quality, basics of water treatment

Working program of the academic discipline (Syllabus)

Details of the academic discipline	
Level of higher education	***First (Bachelor)***
Branch of knowledge	*16 Chemical engineering and bioengineering*
Specialty	*161 Chemical technologies and engineering*
Educational program	*Industrial ecology and resource-efficient clean technologies*
Discipline status	*Selective*
Form of education	*full-time/remote/mixed*
Year of training, semester	*3rd year / 5 semesters*
Scope of the discipline	*4 ECTS credits (120 years)*
Semester control/ control measures	*Test/MCW*
Lessons schedule	*4 hours per week (1 hour of lectures and 3 hours of laboratory classes)*
Language of teaching	*Ukrainian*
Information about head of the course / teachers	Lecturer:*https://eco-paper.kpi.ua/pro-kafedru/vykladachi/tverdokhlib-mariya-mikolajivna.html* *Laboratory classes:https://eco-paper.kpi.ua/pro-kafedru/vykladachi/tverdokhlib-mariya-mikolajivna.html*
Placement of the course	*https://do.ipo.kpi.ua/course/view.php?id=5911*

Program of educational discipline

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

It is known that Ukraine belongs to the low-water countries of the world. The problem of our country is not even the amount of natural waters, but their uneven distribution and high level of pollution. Along with other reasons, the low level of water purification technologies and disorganized water consumption contribute to this. Today, there are practically no reservoirs in Ukraine where the water quality corresponds to the 1st category. In many cases, the quality of drinking water and artesian water does not correspond. Often, the population consumes spring water without proper quality control. Existing water quality control laboratories do not always have the ability to comprehensively analyze the state of certain waters. Therefore, the training of specialists who have high-level knowledge of water quality assessment and water treatment technologies is necessary. Simply choosing equipment without a deep understanding of the chemistry and mechanism of water purification does not allow you to create reliable technologies that ensure high efficiency of water purification. It is also obvious that effective wastewater treatment will improve the state of water ecosystems in Ukraine.

The subject of the educational discipline "Characteristics of water quality, basics of water treatment" *is the implementation of the theoretical foundations of water preparation and water use in water treatment processes, depending on the impurities contained in it, which will ensure the proper quality of purified water.*

To a large extent, the solution to this problem will be determined by the level of training of specialists working in the field of environmental protection, including individual enterprises, institutions, and organizations.

In order to successfully solve the tasks of protecting and preserving natural water bodies, such specialists must be well versed in modern methods and technologies of water purification and water treatment.

The goal of the educational discipline is the formation of students of a set of knowledge related to the solution of water purification from dissolved and insoluble impurities, a set of skills and abilities necessary for conducting scientific research in this direction, for the creation of modern and new methods and technologies for the preparation of drinking water water and wastewater treatment, for qualified management of technological processes in the field of water supply for industry and utilities.

According to the goal, the training of bachelors in this specialty requires students to develop the following competencies:

- *the ability to use the theoretical foundations of ecology, environmental protection and balanced nature management, basic principles and components of environmental management.*
- *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 the state of human health and the quality of the environment.*
- *the ability to apply modern experimental methods of working with technological objects in industrial and laboratory conditions.*

According to the requirements of the educational discipline program ***"Characteristics of water quality, basics of water treatment"****, after mastering it, students must demonstrate the following learning outcomes:*

- *understand basic environmental laws, rules and principles of environmental protection and nature management;*
- *choose and use appropriate equipment, tools and methods for solving complex problems of chemical engineering, control and management of technological processes of chemical production;*
- *carry out qualitative and quantitative analysis of substances of inorganic and organic origin, using appropriate methods of general and inorganic, organic, analytical, physical and colloidal chemistry.*

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

Studying the discipline ***"Characteristics of water quality, basics of water treatment"*** *is based on the principles of integration of various knowledge acquired by students during the bachelor's degree when studying natural and engineering disciplines: "General and inorganic chemistry", "Organic chemistry", "Analytical chemistry", "Auxiliary chemicals", "Industrial ecology", " Chemistry of high molecular compounds".*

Discipline ***"Characteristics of water quality, basics of water treatment"*** *is a fundamental basis for studying the following disciplines: "Environmental safety of production", "Control and management of chemical-technological processes", and ensures the implementation of a bachelor's project.*

3. Content of the academic discipline

Chapter 1. Characteristics of natural waters. General requirements for water quality.

Topic 1 Characteristics of water composition of natural sources of water supply.

Topic 2. Water quality requirements and their classification.

Chapter 2. Physico-chemical foundations of water treatment processes.

Topic 3. Methods and methods of water treatment.

Topic 4. Reagent (chemical) methods of water softening.

Topic 5. Coagulation in the processes of water purification and water treatment.

Topic 6. Theoretical foundations of ion-exchange desalination and water softening.

Topic 7. Use of ion exchange to remove biogenic elements from natural waters.

Topic 8. Membrane methods of water purification.

Topic 9. Fundamentals of removing iron and manganese compounds from water.

4. Educational materials and resources

Basic literature

1. *Gomelya M.D., Shablii T.O., Radovenchyk Y.V. Physico-chemical basics of water purification processes: a textbook. - K.: Condor Publishing House, 2019. - 256 p.*
2. *Radovenchik Y.V., Homelya M.D. Physico-chemical methods of water purification. Textbook. - K.: Condor Publishing House, 2016. - 264 p.*
3. *Shablii T.O., Radovenchyk V.M. Gomelya M.D. Application of new reagents and technologies in industrial water consumption. - K.: Infodruk, 2014. – 302p.*
4. *Characteristics of water quality, basics of water treatment. Laboratory practicum [Electronic resource]: teaching. manual for students specialties 101 "Ecology", 161 "Chemical technologies and engineering" / KPI named after Igor Sikorskyi; compiled by: M. D. Gomelya, T. O. Shablii, Yu. V. Nosachova, M. M. Tverdokhlib - Electronic text data (1 file: 1.02 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 69 p.*

Additional literature

5. *Trus I.M., Galysh V.V., Skyba M.I., Radovenchyk Y.V., Gomelya M.D. New highly effective methods of cleaning from soluble and insoluble pollutants: monograph. / – K.: Condor Publishing House, 2020. – 272 p.*
6. *DSanPiN 2.2.4-171-10 Hygienic requirements for drinking water intended for human consumption. Kind. officer Kyiv, 2010. [Effective from 01.07.2010 with changes introduced in accordance with the Orders of the Ministry of Health dated 18.02.2022 No. 341]*
7. *European Union Council Directive 98/83/EC of November 3, 1998 on the quality of water intended for human consumption.*
8. *I.M. Trus Low-waste water demineralization technologies: monograph. - K.: Condor Publishing House, 2016. - 250 p.*
9. *Zapolsky A.K. Water supply, drainage and water quality: Textbook. - K.: Higher school. 2005 - 671 p.*
10. *Gomelya, M.D., Tverdokhlib, M.M., Vozna, I.P. Mechanism of sorption-catalytic water purification from manganese ions / Bulletin of NTUU "KPI named after Igor Sikorsky". Series: Chemical engineering, ecology and resource conservation, 2020. - No. (3), p. 58-65.*
11. *Gomelya, M.D., Tverdokhlib, M.M., Migranova, V.O. Application of magnetite to accelerate the process of iron oxidation. Bulletin of NTUU "KPI named after Igor Sikorskyi". Series: Chemical engineering, ecology and resource conservation, 2020. - No. 4, p. 57-65.*

Information resources on the Internet

12. *Interactive map of river pollution in Ukraine -https://texty.org.ua/water/*
13. *State sanitary norms and rules "Hygienic requirements for drinking water intended for human consumption" -https://zakon.rada.gov.ua/laws/show/z0452-10#Text*
14. *State Agency of Water Resources of Ukraine -https://www.davr.gov.ua/*
15. *National Library named after V.I. Vernadsky -http://www.nbuv.gov.ua/*
16. *Electronic archive of educational materials of KPI named after Igor Sikorsky -https://ela.kpi.ua/*

Educational content

5. Methods of mastering an educational discipline (educational component)

Lecture classes

Lectures are aimed at:

- *provision of modern, integral, interdependent knowledge of the discipline* ***"Characteristics of water quality, basics of water treatment"****, the level of which is determined by the target setting for each specific topic;*
- *ensuring creative work of students together with the teacher during the lecture;*
- *education of students' professional and business qualities and development of their independent creative thinking;*
- *forming the necessary interest in students and determining the direction for independent work;*
- *definition at the current level of the development of science in the field of modern methods and processes of water treatment, forecasting the development for the coming years;*
- *reflection of the methodical processing of the material (highlighting of the main provisions, conclusions, recommendations, their clear and adequate formulation)*
- *use for demonstration of visual materials, combining them, if possible, with demonstration of results and samples;*
- *teaching research materials in a clear and high-quality language with observance of structural and logical connections, clarification of all newly introduced terms and concepts;*
- *accessibility for perception by this audience.*

№	The name of the lecture topic and the list of main issues (list of didactic means, references to literature and tasks at the IWS)	Hours
	Chapter 1. Characteristics of natural waters. General requirements for water quality.	
1	***Topic 1. Characteristics of the water composition of natural sources of water supply.*** *Characteristics of surface, ground, underground (artesian) waters. Characteristics of water in coastal regions. Basics of ecological, sanitary and hygienic assessment of water quality in surface reservoirs.* *Literature: [1] p. 8-21; [2] c. 9-18; [3] p. 9-18; [9] p. 53-66* *Task on SRS: Characteristics of fresh water resources. Modern approaches to water quality assessment.*	***2***
2	***Topic 2. Water quality requirements and their classification.*** *Requirements for the quality of water for economic and drinking purposes. The main characteristics of the quality of drinking water, their permissible levels. Requirements for the quality of technical and energy water. Requirements for water quality in agriculture.* *Literature: [1] p. 22-37; [2] c. 18-24; [3] c. 20-24; [9] c. 81-102; c. 528-530.* *Task on SRS: Ecological and hygienic classification of natural water bodies. Calculation of the integral indicator of water quality.*	***2***
	Chapter 2. Physico-chemical foundations of water treatment processes.	
3	***Topic 3. Methods and methods of water treatment.*** *Assessment of the phase-dispersed state of pollutants in water. Choosing a method of water purification from the composition of pollutants. Methods for the extraction of mechanical and colloidal impurities. Removal of impurities of a molecular degree of dispersion from water. Correction of the content of ions in water. Water disinfection.* *Literature: [1] p. 20-21; with. 38-43; [3] c. 18-20; [9] c. 107-122; c. 381-392.* *Tasks on SRS: Basic approaches to choosing the most effective method of cleaning natural waters. Using a combination of cleaning methods. Modern methods and materials used in the processes of water preparation and water purification.*	***2***
4	***Topic 4. Reagent (chemical) methods of water softening.*** *Application of reagents for correcting water hardness. Reagent methods of water softening. Combined methods of reactive water softening. Technologies of disposal and processing of sediments in water softening technologies.* *Literature: [3] p. 86-151; [8] c. 8-34; [9] c. 462-472.*	***2***

	Task on SRS: Water softening for industrial needs. Use of complex reagents.	
5	***Topic 5. Coagulation in the processes of water purification and water treatment.*** *Coagulation and flocculation in the processes of clarification and decolorization of water. Regulation of the main parameters of the coagulation and flocculation process. The effect of reagents on the effectiveness of clarification and discoloration of water during its settling, flotation or filtration.* *Literature: [1] p. 39-113; [2] c. 42-48; [3] c. 7-85; [9] c. 190-242.* *Assignment on SRS: Theory of stability of ion-stabilized colloidal systems. Conditions of coagulation of lyophobic colloidal systems. Coagulation kinetics of hydrophobic sols.*	***2***
6	***Topic 6. Theoretical foundations of ion-exchange desalination and water softening.*** *Application of ion exchange water softening and desalination in the preparation of drinking, technical and energy water. Methods of regeneration of ion exchange filters. Processing of regeneration solutions.* *Literature: [1] p. 165-193; [2] c. 130-136; [3] c. 174-196; [8] p. 60-70; [9] p. 394-419.* *Tasks on SRS: Selectivity of ions. Use of mixed action filters for water desalination.*	***2***
7	***Topic 7. Use of ion exchange to remove biogenic elements from natural waters.*** *Purification of ground and surface waters from nitrates and phosphates by the ion exchange method. Regeneration of anionites to obtain bases for liquid fertilizers.* *Literature: [1] p. 241-244; [3] c. 196-209.* *Tasks for SRS: Biochemical purification of water from nitrates and phosphates. Use of biosorbents for water purification.*	***2***
8	***Topic 8. Membrane methods of water purification*** *The use of membrane methods of demineralization in the processes of further purification of tap water, purification of artesian and surface waters in the purification of drinking water. Application of baromembrane methods in obtaining technical and energy water. Utilization of concentrates.* *Literature: [1] p. 195-221; [2] c. 181-199; [3] c. 218-244; [8] p. 83-146; [9] p. 242-460.* *Tasks on SRS: Stabilization treatment of water in membrane purification processes. Application of antiscalants in baromembrane water purification processes.*	***2***
9	***Topic 9. Fundamentals of removing iron and manganese compounds from water.*** *Iron removal and demanganization during the preparation of drinking water. Application of simplified aeration, ion exchange, catalytic oxidation and combined methods.* *Literature: [1] p. 238-239; [9] c. 477-480; [10] p. 58-65.; [11] p. 57-65.* *Task on SRS: Peculiarities of the composition of ferrum and manganese compounds in natural waters. Application of natural materials for iron removal and demanganization of water.*	***2***
	Total hours	***18***

Laboratory classes

In the system of professional training of students, laboratory classes occupy 75% of the classroom load. Being a supplement to the lecture course, they lay and form the basis of the qualification of the nature management organizer. The purpose of laboratory-practical classes is the development of students' experimental skills, a research approach to studying the subject, and consolidation of theoretical material.

№	*Title of laboratory work*	*Hours*
1	*Introduction. Instruction on safety techniques, familiarization with the program of laboratory work, issuing of methodical literature.*	***2***
2	*Determination of iron and manganese ions in water.*	***6***
3	*Determination of water mineralization by massometric and conductometric methods.*	***8***

4	*Determination of nitrates in water.*	***6***
5	*De-ironing of water by aeration method.*	***8***
6	*Use of magnetite-based catalysts for deironing water.*	***6***
7	*Removal of nitrates from water by the ion exchange method.*	***6***
8	*Regeneration of AB-17-8 anionite in NO^{3-} - in the form of an alkali.*	***6***
9	*Modular control work.*	***2***
10	*Test.*	***2***
	Total hours	***54***

6. Independent work of a student/graduate student

Independent work takes up 40% of the time of studying the credit module, including preparation for the credit. The main task of students' independent work is the acquisition of scientific knowledge in areas that are not included in the list of lecture questions through personal search for information, formation of an active interest in a creative approach to educational work. In the process of independent work within the framework of the educational component, the student must learn to deeply analyze modern approaches to the development and implementation of the latest water treatment technologies, based on the characteristics of water and requirements for the quality of purified water. He must be able to create the most effective methods of water purification.

No. z/p	***The name of the topic submitted for independent processing***	***Number of hours of IWS***
	Chapter 1. Characteristics of natural waters. General requirements for water quality.	
1	*Water resources of Ukraine. Dynamics of water resources use in Ukraine. Water consumption by utilities, industry and agriculture. Characteristics of fresh water resources. Modern approaches to water quality assessment.* ***Literature: [1] c. 8-37; [2] c. 9-31; [5] p. 1-41; [8] pp. 49-55; [9] p. 42-71.*** *Ecological and hygienic classification of natural water bodies. Soluble and insoluble impurities in water. Calculation of the integral indicator of water quality. Requirements for the quality of water for various purposes.* ***Literature: [1] c. 85-113; [3] c. 70-97.***	***16***
	Chapter 2. Physico-chemical foundations of water treatment processes.	
2	*Basic approaches to choosing the most effective method of cleaning natural waters. Using a combination of cleaning methods. Modern methods and materials used in the processes of water preparation and water purification.* ***Literature: [1] p. 20-21; with. 38-43; [3] c. 18-20; [9] c. 107-122; c. 381-392.*** *Water softening for production needs. Use of complex reagents. Processing of reagent water softening waste. Modern approaches to creating conditions for deep softening of water. Alkalinity adjustment during deep water softening.* ***Literature: [2] c. 25-250; [3] p. 86-151; [8] c. 8-34; [9] c. 462-472.*** *Theory of stability of ion-stabilized colloidal systems. Conditions of coagulation of lyophobic colloidal systems. Coagulation kinetics of hydrophobic sols. The main types of reagents for water clarification. Advantages and disadvantages of metal salts in water purification. Organic coagulants.* ***Literature: [1] c. 38-84; [2] c. 32-48; c. 58-69; [5] p. 132-156; [9] p. 213-234.*** *Selectivity of ions. Synthetic ionites, main methods of production. Use of mixed action filters for water desalination. Synthetic ionites, main methods of production. Costs of reagents for ionite regeneration depending on the type of ions and ionite.*	***24***

	Literature: [1] c. 165-193; [2] c. 130-159; [3] c. 174-196; [8] p. 60-70; [9] p. 397-413. *Stabilization treatment of water in membrane purification processes. Application of antiscalants in baromembrane water purification processes. Use of reverse osmosis units for domestic and industrial purposes.* ***Literature: [1] c. 195-221; [2] c. 181-209; [3] c. 218-244; [8] p. 83-146.; [9] p. 486-488.*** *Features of the composition of ferrum and manganese compounds in natural waters. Application of natural materials for iron removal and demanganization of water. Necessary conditions for the process of oxidation of iron and manganese compounds in an aqueous environment.* ***Literature: [1] p. 238-239; [9] c. 477-480; [10] p. 58-65.; [11] p. 57-65.***	
3	***Preparation for MKW***	***4***
4	***Preparation for the test***	***4***
	Total hours	***48***

Provision of program results by components of the educational component

The name is OK	*Lecture classes*	*Practical and laboratory classes, individual assignments*
Understand basic environmental laws, rules and principles of environmental protection and nature management.	*Lecture 1. Characteristics of the water composition of natural sources of water supply.* *Lecture 2. Water quality requirements and their classification.*	
Choose and use appropriate equipment, tools and methods for solving complex problems of chemical engineering, control and management of technological processes of chemical production.	*Lecture 3. Methods and methods of water treatment.* *Lecture 4. Reagent (chemical) methods of water softening.* *Lecture 5. Coagulation in the processes of water purification and water preparation.* *Lecture 7. . Use of ion exchange to remove biogenic elements from natural waters.* *Lecture 8. Membrane methods of water purification.* *Lecture 9. Basics of removing iron and manganese compounds from water.*	*Laboratory lesson 5.* *De-ironing of water by aeration method.* *Laboratory lesson 6.* *Use of magnetite-based catalysts for deironing water.* *Laboratory session 7.* *Removal of nitrates from water by the ion exchange method* *Laboratory session 8.* *Regeneration of AB-17-8 anionite in NO^{3-} - in the form of an alkali.*
Carry out qualitative and quantitative analysis of substances of inorganic and organic origin, using appropriate methods of general and inorganic, organic, analytical, physical and colloidal chemistry.		*Laboratory lesson 2.* *Determination of iron and manganese ions in water.* *Laboratory lesson 3.* *Determination of water mineralization by massometric and conductometric methods.* *Laboratory session 4.* *Determination of nitrates in water.*

Policy and control

7. Policy of academic discipline (educational component)

Rules of attending classes and behavior in classes

Students are obliged to take an active part in the educational process, not to be late for classes and not miss them without a good reason, not to interfere with the teacher conducting classes, not to be distracted by activities unrelated to the educational process.

Rules for assigning incentive and penalty points

incentive points can be awarded by the teacher exclusively for the performance of creative works in the discipline or additional completion of online specialized courses with the receipt of the appropriate certificate:

- *https://www.coursera.org/learn/water-treatment*
- *https://www.shortcoursesportal.com/studies/56436/introduction-to-drinking-water-treatment.html*
- *https://www.shortcoursesportal.com/studies/113424/drinking-water-treatment.html?ref=search_card*
- *https://www.watura.fr/online-training-catalogue/drinking-water/treatment-steps-for-drinking-water-production/?lang=en*
- *https://tinyurl.com/2j6n2dd6*

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

Penalty points are not provided within the academic discipline.

Policy of deadlines and rescheduling

In the event of arrears from the academic discipline or any force majeure circumstances, students should contact the teacher through the available (provided by the teacher) communication channels to resolve problematic issues and agree on the algorithm of actions for practice.

Policy of academic integrity

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism refers to the absence of references when using printed and electronic materials, quotes, opinions of other authors. Inadmissible tips and write-offs during 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 "Ihor Sikorsky Kyiv Polytechnic Institute". More details:https://kpi.ua/code

Policy of academic behavior and ethics

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, constructively support feedback during classes.

Standards of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute". More details: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 according to the working study plan:

Semester	School time		Distribution of training hours				Control measures		
	Credits	acad. H.	Lectures	Practical	Lab. woks	IWS	MCW	HCW	Semester control
5	4	120	18	-	54	48	1	-	Test

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

A student's credit module rating consists of the points he receives for laboratory work and for writing a module test. Semester control is credit.

System of rating (weighted) points and evaluation criteria

Performing laboratory work.

The weighted point for 1 laboratory work is 10 points. A total of 7 laboratory works are provided.

Criteria for evaluating the performance of laboratory work

Completeness and signs of task completion	*Markets*
The work was completed in full without errors, the report was correctly drawn up with the appropriate conclusions, the work was submitted for defense in a timely manner, the student shows deep knowledge of the issues of the work, confidently and in detail answers the questions asked during the defense.	*10*
The work was completed in full with minor errors or inaccuracies, in general, the protocol was correctly drawn up with relevant conclusions, the work was submitted for defense in a timely manner, during the defense of the work, the student shows knowledge of the work, almost confidently answers the questions;	*8-9*
The work was completed in full with minor errors or inaccuracies with vaguely formulated conclusions, the work was submitted for defense in a timely manner, during the defense the student shows insecurity, shows weak knowledge of the work, does not always give comprehensive answers to questions.	*7-5*
The work was not completed in full, there are no conclusions in the work, the work was submitted for defense late during the defense, the student cannot answer any of the questions on the topic of the work.	*1-4*
The work is not done.	*0*

Modular control works

Weighted score – 15 points. The maximum number of points for all test papers is equal to:

15 points x2 work = 30 points

Evaluation criteria of control works

Completeness and signs of response	*Markets*
Complete answer (at least 90% of the required information), examples are given	*15*
Incomplete disclosure of one of the questions or a complete answer with minor inaccuracies	*9-14*
An incomplete answer (at least 60% of the required information) and minor errors	*4-8*
The answer is superficial without analysis of parameters, conditions, materials, facts, incomplete conclusions	*1-3*
Control work is not counted	*0*

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

$$R_c = 10 \cdot 7 + 15 \cdot 2 = 100 \text{ points}$$

Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements. According to the results of educational work in the first 7 weeks, the "ideal student" should score 40 points. At the first certification (8th week), the student receives "credited" if his current rating is at least 20 points.

According to the results of educational work for 18 weeks of study, the "ideal student" should score 90 points. At the second certification (16th week), the student receives "credited" if his current rating is at least 40 points.

The maximum number of points is 100. To receive credit from the credit module "automatically" you need to have a rating of at least 60 points. A necessary condition for admission to the credit is a rating of at least 40% of the rating scale (R), i.e. 40 points.

Students who scored a rating of less than 0.6 R during the semester, as well as those who want to improve the overall rating, complete a credit test. At the same time, all the points they received during the semester are cancelled. Test tasks contain questions that refer to different sections of the credit module. The list of assessment questions is provided in Section 9. To obtain an assessment grade, the sum of all rating points R received during the semester is translated according to the table:

Scores	***Rating***
95...100	*perfectly*
85...94	*very good*
75...84	*well*
65...74	*satisfactorily*
60...64	*enough*
RD <60	*disappointing*
Admission conditions not met	*not allowed*

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

Pa detailed list of questions submitted for semester control

1. *Describe the ecological state of surface water supply sources.*
2. *List the physical and chemical indicators of water quality.*
3. *Describe the organoleptic and bacteriological indicators of water quality.*
4. *State the ecological and hygienic requirements for the quality of drinking water from surface and underground sources of water supply.*
5. *What water quality standards do you know? What documents are they defined by?*
6. *State the requirements for the quality of economic and drinking water, technical and energy water.*
7. *Give the classification of pollution by phase-disperse composition.*
8. *What methods of adjusting the chemical composition of water and organoleptic properties do you know?*
9. *What determines the choice of water purification method?*
10. *Describe the water purification methods used to remove mechanical and colloidal impurities.*
11. *Name the methods used to remove impurities from species in the molecular state.*
12. *What are the methods of correcting the content of ions in water used for?*
13. *Name the main methods of water disinfection and the conditions for their use?*
14. *What is the essence of the reagent water softening method? What is it used for?*
15. *What reagents are used to soften water? Give examples.*
16. *Offer technologies for the utilization and processing of sediments produced in the process of reactive softening of water.*
17. *What methods are used to lighten and decolorize water?*
18. *What is the essence of the method of water purification by the method of coagulation and flocculation?*
19. *Describe the coagulants used to purify natural waters.*
20. *Name the flocculants used in water treatment technologies.*
21. *What is the essence of ion exchange water softening and desalination? Where is it used?*
22. *Describe the ion exchange materials used to soften water.*
23. *Present the forms of ionites and methods of their regeneration.*
24. *What is the essence of ion-exchange purification of ground and surface waters from nitrates and phosphates?*
25. *What types of ion exchange materials are used to capture nitrate and phosphate anions?*
26. *Give methods of regeneration of anionites after removal of nitrates and phosphates with obtaining valuable components.*
27. *Describe the membrane methods of water demineralization.*
28. *Give the classification of membranes.*
29. *Compare baromembrane processes used in water treatment. What determines the choice of one or another method.*

30. Suggest methods of disposal of concentrates formed during membrane water purification.

31. Give the methods used for iron removal and demanganization of water.

32. What materials of natural and synthetic origin are used in the processes of extracting ferrum and manganese compounds from water.

33. What is the essence of modifying filter loadings for oxidation of ferrum and manganese compounds? Give examples of such downloads.

Working program of the discipline (syllabus):

Compiled *senior lecturer, Ph.D., Tverdokhlib M. M.*

Approved *by the Department of E and TRP (protocol № 14 from _ 05/08/2023)*

Approved *by the Methodical commission of the faculty (protocol № 10 from 05/26/2023)*