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

Ecology and Plant polymers technology

# Characteristics of water quality, basics of water treatment

**Work 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 technology and engineering* |
| **Educational program** | *Industrial ecology and resource-efficient clean technologies* |
| **Discipline status** | *Selective* |
| **Form of education** | *part-time/remote/mixed* |
| **Year of training, semester** | *3rd year/5th semester* |
| **Scope of the discipline** | *4 ECTS credits ( 120 hours )* |
| **Semester control/ control measures** | *Test* |
| **Lessons schedule** | *8 hours of lectures and 12 hours of laboratory classes.* |
| **Language of teaching** | *Ukrainian* |
| **Information about the 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 states 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 treatment 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 protection and preservation of natural water bodies, such specialists should be well acquainted with modern methods and technologies of water purification and water preparation .*

*The goal of the educational discipline is the formation of a set of knowledge in students 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 choose and use appropriate equipment, tools and methods for control and management of technological processes of chemical production;*
- *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;*
- *the ability to apply up-to-date experimental methods of working with technological objects in industrial and laboratory conditions.*

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

- *to 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;*
- *to select and use appropriate equipment, tools and methods to solve complex problems of chemical engineering, control and management of technological processes of chemical production;*
- *to understand the basic environmental laws, rules and principles of environmental protection and nature management.*

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

*Study of 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: "Hydrology", "Chemistry with the basics of biogeochemistry", "Special sections of biogeochemistry", "Organic chemistry", "Analytical chemistry".*

*Discipline* ***" Characteristics of water quality, basics of water treatment "*** *is a fundamental basis for studying the following disciplines: "Water purification technologies", " Water treatment in industry and utilities", "Mechanical and biological processes of liquid waste disposal", " Design of water supply systems", "Circulating and closed water consumption systems", "Centralized water supply systems", " Design of treatment facilities and water use systems", "Purification processes and equipment water", "Water treatment stations", " Resource-efficient water circulation systems", "Water supply and drainage of the most water-intensive enterprises", "Industrial water supply systems without discharge of wastewater into the environment" and ensures the implementation of the bachelor's project .*

## *3.* Content of the academic discipline

***Chapter 1. Characteristics of natural waters. general water quality requirements .***

*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. Basics 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]: training . help for studies specialties 101 "Ecology", 161 "Chemical technologies and engineering" / KPI named after Igor Sikorskyi; edited by: M. D. Gomelya, T. O. Shablii , Yu. V. Nosachova , M.M. Solid Bread - Electronic text data (1 file: 1.02 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 69 p.*
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.*


### *Additional literature*


6. *DSanPiN 2.2.4-171-10 Hygienic requirements for drinking water intended for human consumption. Kind. officer Kyiv 2010*
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 Sikorskyi". 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 Ihor 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 educational materials of KPI named after Igor From Ikorskyi – https :// ela . kpi u /*

## Educational content

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

**Lecture classes**

*Lectures are aimed at:*

- *provision of modern, integral, interdependent knowledge in the discipline **" Water quality characteristics, 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)*
- *the use of visual materials for demonstration, their combination, if possible, with the 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.*

| No. | 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 water quality requirements .** | |
| 1 | **Topic 1. Characteristics of the water composition of natural sources of water supply.** *Characteristics of surface, ground , underground (artesian) waters. Basics of ecological, sanitary and hygienic assessment of water quality in surface reservoirs. 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. 8 - 37 ; [2] c. 9-24; [ 3 ] p. 9 - 20 ; [ 9 ] p. 53 - 66; c. 81 - 102.* *Tasks on the IWS: Characteristics of fresh water resources. Modern approaches to water quality assessment. Environmental - hygienic classification of natural water bodies. Calculation of the integral indicator of water quality.* | 1 |
| | **Chapter 2. Physico-chemical foundations of water treatment processes .** | |
| 2 | **Topic 2. 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 the IWS: 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 .* | 1 |
| 3 | **Topic 3. 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 utilization and processing of sediments in water softening technologies.* *Literature: [ 3 ] p. 86 - 151 ; [ 8 ] c. 8-3 4 ; [ 9 ] c. 462 - 472 .* *Tasks on the IWS: Water softening for production needs. Use of complex reagents.* | 1 |
| 4 | **Topic 4. Theoretical foundations of ion exchange desalination and water softening.** *Application of ion exchange water softening and desalination in the preparation of* | 1 |

| | | |
|---|---|---|
| | *drinking, technical and energy water. Methods of regeneration of ion exchange filters. Processing of regeneration solutions.*<br>*Literature: [1] p. 165-193; [2] c. 130-136; [3] c. 174-196; [8] p. 60-70; [9] p. 394-419.*<br>*Tasks on the IWS: Selectivity of ions. Using mixed action filters for water desalination .* | |
| *5* | ***Topic 5 . Membrane methods of water purification***<br>*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.*<br>*Literature: [ 1 ] p. 195 - 221 ; [ 2 ] c. 181-199 ; [ 3 ] c. 218 - 244 ; [ 8 ] p. 83 - 146; [ 9 ] p. 242 - 460.*<br>*Tasks on the IWS: Stabilization treatment of water in membrane purification processes. Application of antiscalants in baromembrane water purification processes.* | ***1*** |
| *6* | ***Topic 6 . Basics of removing iron and manganese compounds from water .***<br>*Iron removal and demanganization during the preparation of drinking water. Application of simplified aeration, ion exchange, catalytic oxidation and combined methods.*<br>*Literature: [ 1 ] p. 238 - 239 ; [ 9 ] c. 477 - 480; [ 10 ] p. 58-65.; [ 11 ] p. 57-65.*<br>*Tasks on the IWS: Peculiarities of the composition of ferrum and manganese compounds in natural waters. Application of natural materials for iron removal and demanganization of water.* | ***1*** |
| *7* | ***Test*** | ***2*** |
| | ***Total hours*** | ***8*** |

**Laboratory classes**

*In the system of professional training of students, laboratory classes occupy 75 % of the classroom load. As 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.*

| ***No.*** | ***Title of laboratory work*** | ***Hours*** |
|---|---|---|
| *1* | *Introduction. Instruction on safety techniques, familiarization with the program of laboratory work, issuing of methodical literature.* | ***2*** |
| *2* | *Definition iron ions and manganese in water* | ***2*** |
| *3* | *Application magnetite - based catalysts for deironing water.* | ***2*** |
| *4* | *Withdrawal nitrates from water ion exchange method.* | ***2*** |
| *5* | *Regeneration of anionite AB-17-8 in $NO^{3-}$ - in the form of a meadow.* | ***2*** |
| *6* | *Performing a modular test.* | ***2*** |
| | ***Total hours*** | ***12*** |

## *6.* Independent work of a student/graduate student

*Independent work takes 85 % of time 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. | The name of the topic submitted for independent processing | Number of hours of IWS |
|---|---|---|
| **Chapter 1. Characteristics of natural waters. general water quality requirements .** | | |
| 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.**<br><br>*Environmental - 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 ] 70-97.** | **30** |
| **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.**<br><br>*Water softening for production needs. Use of complex reagents. Reagent waste processing water softening Modern approaches to creating conditions for deep softening of water. Alkalinity adjustment during deep softening of water.* **Literature: [2] c. 25-250; [3] p. 86-151; [8] c. 8-34; [9] c. 462-472.**<br><br>*Selectivity of ions. Synthetic ionites, main methods of production. Using 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.* **Literature [1] c. 165-193; [2] c. 130-159; [3] c. 174-196; [8] p. 60-70; [9] p. 397-413.**<br><br>*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.**<br><br>*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.** | **6 4** |
| 3 | **Preparation for a modular test** | **6** |
| 4 | **Preparation for the test** | **6** |
| | **Total hours** | **100** |

***Provision of program results by components of the educational component***

| *The name is OK* | *Lecture classes* | *Practical and laboratory classes, individual assignments* |
|---|---|---|
| *To understand the 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. Methods and methods of water treatment.* | |
| *The ability to choose and use appropriate equipment, tools and methods for control and management of technological processes of chemical production* | *Lecture 3. Reagent (chemical) methods of water softening.* *Lecture 4 . Theoretical foundations of ion exchange desalination and water softening.* *Lecture 5 . Membrane methods of water purification.* *Lecture 6 . Basics of removing iron and manganese compounds from water .* | *Laboratory lesson 2 . Application magnetite - based catalysts for deironing water.* *Laboratory lesson 3. Withdrawal nitrates from water ion exchange method .* |
| *To 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 1. Definition iron ions and manganese in water* *Laboratory session 4. Regeneration of anionite AB-17-8 in $NO^{3-}$ - in the form of a meadow.* |

## 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 to miss them without a good reason, not to interfere with the teacher conducting classes, not to be distracted by actions 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.coursera.org/learn/water-an-essential-resource*
  - *https://www.watura.fr/_o_nline-training-catalogue/drinking-water/treatment-steps-for-drinking-water-production/?lang=en*
  - *https: / /tinyurl.co m /2j6n2 d d6*

  *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 in accordance with the working curriculum:*

| Semester | Study time | | Distribution of study hours | | | | Control measures | | |
|---|---|---|---|---|---|---|---|---|---|
| | Credits | Acad. hours | Lectures | Practical | Lab. woks | IWS | MCT | HSW | Semester control |
| 5 | 4 | 120 | 8 | - | 12 | 100 | 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 15 points. A total of 4 laboratory works are provided.*
*Criteria for evaluating the performance of laboratory work*

| Completeness and signs of task completion | Points |
|---|---|
| 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. | 15 |
| 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; | 14-11 |
| The work was completed in full with minor errors or inaccuracies with vaguely formulated conclusions, the work was submitted for defense on time, during the defense the student shows insecurity, shows weak knowledge of work issues, does not always give comprehensive answers to questions. | 10 -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*

*The maximum number of points for a modular control work is equal to: 40 points*

*Evaluation criteria of the control work*
*Evaluation criteria of control works*

| *Completeness and signs of response* | *Points* |
|---|---|
| *Complete answer (at least 90% of the required information), examples are given* | *40* |
| *Incomplete disclosure of one of the questions or a complete answer with minor inaccuracies* | *39-30* |
| *An incomplete answer (at least 60% of the required information) and minor errors* | *29-20* |
| *The answer is superficial without analysis of parameters, conditions, materials, facts, incomplete conclusions* | *19-1* |
| *Control work is not counted* | *0* |

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

$$R_c = 15 \cdot 4 + 40 = 100 \text{ points}$$

*The maximum number of points is 100. In order to receive a 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 the enrollment of all types of work - laboratory and MCR, while the rating must be 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*** |
|---|---|
| *9 5 ...100* | *perfectly* |
| *8 5 ... 9 4* | *very good* |
| *75...8 4* | *fine* |
| *6 5 ...74* | *satisfactorily* |
| *60...6 4* | *enough* |
| *RD <60* | *unsatisfactorily* |
| *Admission conditions not met* | *not allowed* |

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

***APPROXIMATE list of questions submitted for semester control***

1. *Describe the ecological condition 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 formed 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 academic discipline ( syllabus ):***
***Folded*** *senior lecturer, Ph.D., Tverdokhlib M. M.*

***Approved by*** *the Department of E and TRP (protocol № 17 from 23.05.2024)*

***Agreed by*** *the Methodical commission of the faculty (protocol № 11 from 28.06.2024)*