Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Ecology and technology of plant polymers

Water supply and sanitation in industry
Work program of the discipline (Syllabus)

Requisites of the discipline

Level of higher education	***Bachelor***
Field of expertise	*10 Natural sciences*
Speciality	*101 Ecology*
Educational program	*Environmental safety*
Discipline status	*Custom*
Form of education	*full-time / remote / mixed*
Year of preparation, semester	*3 course/6 semester*
Scope of discipline	*4(120)*
Semester Control/ Control Measures	*Passed*
Schedule of classes	*4 hours per week (1 hour of lectures, 1 hour of practical classes and 2 hours of laboratory classes)*
Language of instruction	*Ukrainian*
Information about the course /teachers	Lector: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/trus-inna-mikolajivna.html* Practical/Seminar: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/trus-inna-mikolajivna.html* *Laboratory classes: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/trus-inna-mikolajivna.html*
Course placement	*https://do.ipo.kpi.ua/course/*

The program of the discipline

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

Due to the long-term increase in anthropogenic load, environmental pollution occurs. Today it is impossible to imagine human existence without constant water supply, and the problem of pollution of water supply sources is becoming increasingly important. Some regions of the planet suffer from a catastrophic shortage of water, in addition, they face another problem – poor quality of water resources. Therefore, the development of reliable, environmentally friendly and cost-effective methods of water treatment is a priority for environmental protection. To solve just such a problem, training of specialists in the field of environmental protection is directed. To successfully solve the problems of protection and conservation of natural water bodies, such specialists should be well aware of modern methods and technologies of water purification.

The subject of the discipline "Water supply and sanitation in industry" *is the implementation of approaches that will provide high-quality water treatment of various quality, reliable wastewater treatment, sludge dewatering for the complete transition of industrial enterprises to the use of drainless (closed) water consumption systems.*

To a large extent, the solution of this problem will be determined by the level of training of specialists working in the field of environmental protection, including institutions of environmental safety management of the state, scientific institutions and organizations, enterprises. To successfully solve the problems of protection and preservation of natural aquatic ecosystems, specialists must be fluent in information, be able to solve complex problems of protecting water bodies from pollution at a high professional level.

The purpose of the discipline "Water supply and sanitation in industry"

The purpose of studying this discipline is to form students' complex of knowledge in the field of modern physicochemical methods of water purification, a set of skills and abilities necessary for conducting research in this direction, for creating modern technologies for rational use of water, for qualified public administration and regulation of relations in the field of drinking water, drinking water supply and sewage. In accordance with the goal, the preparation of bachelors requires strengthening the competencies formed by students:

- *ability to improve, design, implement and operate technologies and equipment for treatment and processing of exhaust gases, wastewater and solid waste;*
- *ability to critically reflect on the basic theories, methods and principles of natural sciences;*
- *Ability to design and implement technologies for treatment and processing of exhaust gases, wastewater and solid waste.*

*According to the requirements of the program of the discipline "**Water supply and sanitation in industry",** students after mastering it must demonstrate the following program learning outcomes:*

- *be able to search for information using appropriate sources to make informed decisions;*
- *be able to choose the best methods and tools for research, data collection and processing;*
- *develop technologies, use processes and devices that ensure effective separation, concentration, extraction, destruction of harmful impurities in water systems and gas environments, waste processing and disposal.*

2. Prerequisites and post-details of the discipline (place in the structural and logical scheme of training in the relevant educational program)

*The study of the discipline "**Water supply and sanitation in industry**" is based on the principles of integration of various knowledge gained by students during the bachelor's degree in the study of natural and engineering disciplines: "Hydrology", "Chemistry with the basics of biogeochemistry", "Special sections of biogeochemistry", "Organic chemistry", "Analytical chemistry".*

*The discipline "Water supply and **sanitation** in industry" 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 utilization", "Design of water supply systems", "Reversible and closed water consumption systems", "Centralized water supply systems", "Design of treatment plants and water use systems", "Processes and equipment water purification", "Water treatment stations", and ensures the implementation of the bachelor's project.*

3. The content of the discipline "Water supply and sanitation in industry"

Section 1. Industrial water supply and water consumption systems

Topic 1. The concept of water supply and water consumption

Topic 2. Modern approaches to stabilization water treatment for closed industrial water supply systems

Section 2. Sorption and destructive methods of water purification

Topic 1: The use of adsorbents in water purification

Topic 2. The use of ion exchange materials in water purification

Topic 3. Methods of disinfection and additional water treatment

Training materials and resources

Basic literature

1. *Gomel M.D., Shabliy T.O., Radovenchyk Ya.V. Physico-chemical bases of water purification processes: textbook. – Kyiv: Condor Publishing House, 2019. – 256 p.*
2. *Radovenchyk Ya.V., Gomelya M.D. Physico-chemical methods of water purification. Textbook. – Kyiv: Condor Publishing House, 2016. – 264 p.*
3. *Gomelya M.D., Krysenko T.V., Omelchuk Yu.A. Methods and technologies of wastewater treatment: Textbook. persons. / – Sevastopol: Institute of Nuclear Energy and Industry, 2012. – 244 p.*
4. *Water supply and sanitation in industry. Laboratory workshop [Electronic resource]: textbook. persons. for studios. specialty 101 "Ecology", 161 "Chemical technologies and engineering" / KPI them. Igor Sikorsky ; compiled by: M. D. Gomelya, T. O. Shabliy, I. M. Trus, O. P. Khotva. –*

Electronic text data (1 file: 1.66 MB). – Kyiv : KPI them. Igor Sikorsky, 2023. – 63 p. – Title from the screen. https://ela.kpi.ua/handle/123456789/54685

5. *Trus I.M., Halysh V.V., Skyba M.I., Radovenchyk Ya.V., Gomelya M.D. New highly effective methods of purification from soluble and insoluble pollutants: monograph. / – K.: Condor-Publishing House, 2020. – 272 p.*

Further reading

6. *Trus I.M., Halysh V.V., Gomelya M.D. Development of methods for processing sediments and spent biosorbents for the creation of low-waste water treatment technologies monograph. – Kyiv: Condor Publishing House, 2023. – 115. p.*
7. *A.K. Zapolsky, N.A. Mishkova-Klymenko, I.M. Astrelin, M.T. Bryk, P.I. Gvozdyak, T.V. Knyazkova. Physico-chemical bases of wastewater treatment technology: Textbook. – K.: Libra. 2000 – 551 p.*
8. *Trus I.M. Low-waste technologies of water demineralization: monograph. – Kyiv: Condor-Publishing House, 2016. – 250 p.*

Information resources on the Internet

9. *Ministry of Environmental Protection and Natural Resources of Ukraine – https://mepr.gov.ua/*
10. *Professional Association of Ecologists of Ukraine (PAEU) - https://ecolog-ua.com/paeu*
11. *Library. V.I. Vernadsky – www.nbuv.gov.ua*
12. *Ecological portal of Ukraine – www.ecologya.com.ua*

Educational content

5. Methods of mastering the discipline (educational component)

Lecture classes

Lectures are aimed at:

- *providing modern, holistic, interrelated knowledge in the discipline "Membrane methods of water purification", the level of which is determined by the target installation for each specific topic;*
- *ensuring the creative work of students together with the teacher during the lecture;*
- *education of students' professional and business qualities and the development of their independent creative thinking;*
- *formation of students' necessary interest and determination of direction for independent work;*
- *determination at the present level of science development in the field of modern methods and processes of water conditioning, forecasting development for the coming years;*
- *reflection of the methodical processing of the material (selection of the main provisions, conclusions,*
  recommendations, their clear and adequate formulation)

-use for demonstration of visual materials, combination, if possible with the demonstration of results and samples;

-teaching research materials in a clear and high-quality language in compliance with structural and logical connections, clarification of all newly introduced terms and concepts;

-accessibility for perception by this audience.

No salary	***The title of the lecture topic and the list of main issues (list of didactic means, references to literature and tasks on the CPC)***	***Hours***
1	***The concept of water supply and water consumption*** *Schemes of water supply from underground and surface sources. Specific water consumption of industry, population and agriculture. Sources of water supply. The main indicators of the quality of drinking and industrial water.* *References: [1] p. 8-37; [2] c. 9-24; [3] c. 9-24; [7] c. 53-102.* *Tasks on the CPC. Characteristics of water in coastal regions. Fundamentals of ecological and sanitary and hygienic assessment of water quality in surface water bodies*	*4*
2.	***Modern approaches to stabilization water treatment for closed industrial water supply systems.*** *Basic principles of creation of reverse and fully closed (drainless) systems of industrial water supply. Water loss during reverse water supply. Determination of*	*6*

	the concentration coefficient of salts. The use of corrosion and scale inhibitors in water-circulating cooling systems. Degassing with the extraction of pedoxites. Ion exchange adjustment of water composition for feeding closed reverse systems. The use of reverse osmosis and electrodialysis methods. *References: [1] p. 195-221; [2] c. 181-195; [7] pp. 242-460.* *Tasks on the CPC. Dialysis, pervaporation. Membrane distillation. Membrane. Obtaining membranes. Stabilization water treatment in membrane purification processes. The use of antiscalants in baromembrane water purification processes.*	
3	***The use of adsorbents in water purification*** *Adsorption water purification, method definition and general concepts. Properties of sorbents. Innovative technologies for the use of sorbents for wastewater treatment from contamination.* *References: [1] p. 135-164; [2] c. 98-105; [7] pp. 239-246.* *Tasks on the CPC. Physical, activated adsorption and chemisorption*	*4*
4	***The use of ion exchange materials in water purification*** *Features of ion exchange water purification. Characteristics of ionites and their regeneration.* *References: [1] p. 165-194; [2] c. 130-136; [7] pp. 193-228; [8] pp. 173-190.* *Tasks on the CPC. Application of the theory of "hard" and "soft" acids and bases to the evaluation of the selectivity of ion exchange resins*	*2*
5	***Methods of disinfection and additional water treatment*** *Classification of disinfection methods. Advantages and disadvantages of reagent (chemical), reagent-free (physical) and combined methods. The use of methods of chlorination, ozonation, use of preparations of argentum, cuprum and others. Ultraviolet and ionizing radiation treatment, ultrasound and heat treatment of water.* *References: [1] p. 223-237; [2] c. 220-224; [7] pp. 460-478.* *Tasks on the CPC. Catalytic vapor-phase oxidation of organic impurities in water.*	*2*
	Just	***18***

6. Practical exercises

In the system of professional training of students in this discipline, practical classes occupy 25% of the classroom load. Being a supplement to the lecture course, they lay and form the foundations of a bachelor's qualification in ecology, namely the protection of water bodies from anthropogenic impact. The content of these classes and the methods of their conduct should ensure the development of the creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow you to test knowledge. Therefore, this type of work is an important means of operational feedback. Practical classes should perform not only cognitive and educational functions, but also contribute to the growth of students as creative workers in the field of environmental protection.

The main objectives of the series of practical classes:

- *help bachelors systematize, consolidate and deepen theoretical knowledge in the field of modern methods and technologies of air conditioning and water purification;*
- *teach students techniques for solving practical problems, promote the mastery of skills and abilities to perform calculations, graphic and other tasks;*
- *teach them to work with scientific and reference literature and diagrams;*
- *to form the ability to learn independently, that is, to master the methods, methods and techniques of self-study, self-development and self-control.*

No salary	***The title of the topic of the practical lesson and the list of main issues (list of didactic support, references to literature and tasks on the CPC)***	***Hours***

1	***The concept of water supply and water consumption*** *Schemes of water supply from underground and surface sources. Specific water consumption of industry, population and agriculture.* *References: [1] p. 8-37; [2] c. 9-24; [3] c. 9-24; [7] c. 53-102.* *Tasks on the CPC. Requirements for water quality for drinking purposes. Requirements for the quality of technical and energy water. Requirements for water quality in agriculture.*	*2*
2	***Modern approaches to stabilization water treatment for closed industrial water supply systems.*** *Basic principles of creation of reverse and fully closed (drainless) systems of industrial water supply. Water loss during reverse water supply. Determination of the concentration coefficient of salts. The use of corrosion and scale inhibitors in water-circulating cooling systems. Degassing with the extraction of pedoxites. Ion exchange adjustment of water composition for feeding closed reverse systems. The use of reverse osmosis and electrodialysis methods.* *References: [1] p. 195-221; [2] c. 181-195; [5] pp. 242-460.* *Tasks on the CPC. The use of baromembrane methods in obtaining process and energy water*	*4*
3	***The use of adsorbents in water purification*** *Adsorption water purification, method definition and general concepts. Properties of sorbents. Innovative technologies for the use of sorbents for wastewater treatment from contamination.* *References: [1] p. 135-164; [2] c. 98-105; [5] pp. 239-246.* *Tasks on the CPC. The influence of the nature of organic molecules on the amount of their adsorption.*	*4*
4	***The use of ion exchange materials in water purification*** *Features of ion exchange water purification. Characteristics of ionites and their regeneration.* *References: [1] p. 165-194; [2] c. 130-136; [5] pp. 193-228; [6] pp. 173-190.* *Tasks on the CPC Selectivity of ionites. Gregor's theory.*	*2*
5	***Methods of disinfection and additional water treatment*** *Features of chemical and physical decomposition of organic substances in water.* *References: [1] p. 223-235.* *Tasks on the CPC. Mechanisms of oxidation of impurities in water.*	*4*
6	*Modular test paper*	*2*
	Just	*18*

7. Laboratory classes

In the system of professional training of students, laboratory classes occupy 50% of the *classroom load. Being a supplement to the lecture course, they lay and form the foundations of the qualification of a bachelor in ecology. The purpose of laboratory and practical classes is to develop students' experimental skills, a research approach to the study of the* subject, and the consolidation of theoretical material.

Title of laboratory work	*Number of classroom hours*
Entry. Safety instruction, familiarization with the program of laboratory work, issuance of methodological literature	*2*
Extraction of phosphates from water by ion exchange method	*4*
Regeneration of anionite AB-17-8 in RO_4^{3-} form with alkali	*4*
Extraction of phosphates from water by the reagent method	*4*
Removal of hardness ions from water by baromembrane method	*4*
Removal of organic impurities from water by baromembrane method	*4*
Reducing the color of water by a destructive method	*4*
Discoloration of wastewater	*6*
Final lesson	*2*

Passed	*2*
Just	*36*

Providing program results by the components of the educational component

Program result	*Lecture classes*	*Practical and laboratory classes, individual tasks*
Atmiti to search for information using appropriate sources to make informed decisions.		*Inservice Lesson 1. The concept of water supply and water consumption* *Inservice lesson 7. Methods of disinfection and additional water treatment*
Miti choose the best methods and tools for research, data collection and processing.		*The lab isnot lesson 2. Extraction of phosphates from water by ion exchange method* *The lab isnot a lesson 3. Extraction of phosphates from water by the reagent method* *The lab is not lesson 4. Removal of hardness ions from water by baromembrane method* *The lab is not a lesson 5. Removal of organic impurities from water by baromembrane method* *The lab isnot a lesson 6. Reducing the color of water by a destructive method* *The lab is not lesson 7. Discoloration of wastewater*
Pdevelop technologies, use processes and devices that ensure effective separation, concentration, extraction, destruction of harmful impurities in water systems and gas environments, processing and disposal of waste.	*Lecture 1, 2. The concept of water supply and water consumption* *Lectures 3, 4, 5. Modern approaches to stabilization water treatment for closed industrial water supply systems* *Lecture 6, 7. The use of adsorbents in water purification* *Lecture 8. The use of ion exchange materials in water purification* *Lecture 9. Methods of disinfection and additional water treatment*	

8. Independent work of the student

Independent work takes 40% of the time studying the credit module, including preparation for the test. The main task of independent work of students is the mastery of scientific knowledge in areas 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. In the process of independent work within the educational component, the student must learn to deeply analyze modern approaches to the development

and implementation of the latest technologies for air conditioning and water purification, based on the characteristics of water and the quality requirements of purified water. He should be able to create the most effective methods of water purification.

No salary	*The name of the topic submitted for independent study*	*Number of hours CPC*
Section 1. Industrial water supply and water consumption systems		
1	*Ecological and hygienic classification of natural water bodies. Soluble and insoluble impurities in water. Calculation of the integral indicator of water quality. Requirements for water quality for various purposes.* *References: [1] p. 8 5-113; [3] c. 70-97.* *Features of water purification on mechanical filters and membrane methods.* *References: [1] p. 195-221; [2] c. 181-188; [7] pp. 337-354.* *Designs of plants for water purification by membrane distillation.* *References: [1] p. 195-221; [2] c. 188-195; [7] pp. 337-354.* *The use of antiscalants in baromembrane water purification processes.* *References: [1] p. 195-221; [2] c. 195-199; [7] pp. 337-354.* *The main methods of obtaining ion exchange membranes and diffusion membranes. Ceramic membranes. Obtaining and applying them. Stabilization water treatment in membrane purification processes.* *References: [1] p. 195-221; [2] c. 181-209; [7] pp. 337-367.*	*26*
Section 2 Sorption and destructive methods of water purification		
2	*Physical, activated adsorption and chemisorption. Porosity of organic, inorganic, natural and synthetic adsorbents. Adsorption selectivity.* *References: [1] p. 135-164; [2] c. 98-116; [7] pp. 239-266; [8] pp. 14-25; 29-69.* *Determination of the working exchange capacity of ionite taking into account kinetic factors. The use of ion exchange in the energy sector. Ion exchange extraction of heavy and non-ferrous metal ions from water. Regenerative regeneration of anionites in chromate form.* *References: [1] p. 165-194; [2] p. 130-159; [7] pp. 193-232, pp. 287-299; [3] pp. 84-146, pp. 173-190, p. 198-21.* *Water ozonation. The use of ozonides.* *References: [1] p. 223-237; [2] c. 210-216; [5] pp. 255-313; [7] pp. 452-478.* *Catalytic vapor-phase oxidation of organic impurities in water.* *References: [1] p. 223-237; [2] c. 216-220; [7] pp. 460-468.* *Designs of electrolyzers. Sources of ionizing radiation.* *References: [1] p. 223-237; [2] c. 220-224; [7] pp. 460-478.* *Ozonides. Methods of obtaining and how to use them.* *References: [1] p. 223-237; [2] c. 210-224; [5] pp. 255-313; [7] pp. 452-478.*	*18*
	Preparing for ICR	*4*
	Total hours	*48*

Policy and control

9. Policy of the discipline (educational component)

Rules for attending classes and behavior in classes

Attendance at classes is a compulsory 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 awarded by the teacher only for performing creative works on the discipline or additional passing of online specialized courses with obtaining the appropriate certificate:*

- *https://www. coursera. org/learn/water-treatment;*
- *https://cropaia.com/water-treatment-pro/;*
- *https://www.shortcoursesportal.com/studies/56436/introduction-to-drinking-water-treatment.html).*

But their amount cannot exceed 25% of the rating scale. Enrollment of a certificate from a certain online profile course is one-time.

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

Deadlines and rebuilds policy

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

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism refers to the lack of references when using printed and electronic materials, quotes, opinions of other authors. Inadmissible hints and cheating when writing tests, conducting classes; passing credit 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 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

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, constructively maintain feedback in the classroom.
The norms of ethical behavior of students and employees are defined in 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

10. Types of control and rating system for assessing learning outcomes (RSO)

Distribution of study time by types of classes and tasks in the discipline according to the working curriculum:

Semester	*Study time*		*Distribution of training hours*				*Control measures*		
	Loans	*Acad. H.*	*Lecture*	*Practical*	*Lab. Rob.*	*CPC*	*FDM*	*RGR*	*Semester control*
5	*4*	*120*	*18*	*18*	*36*	*48*	*1*	*–*	*Passed*

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

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

The student's credit module rating consists of the points that he receives for work in practical classes and laboratory works, for writing a modular test. Semester control is credit.

System of rating (weight) points and evaluation criteria

Performing tasks in practical classes.
The weight score in practical classes is 7 points each; There are 3 performances in class.
Performance of laboratory work.
The weight score for 1 laboratory work is 7 points.
Criteria for evaluating the implementation of practical tasks and laboratory works

Completeness and signs of the task	*Practical classes Laboratory classes*

The task is fully completed	*7*
Minor deficiencies under paragraph 1	*6*
Late completion of the task	*4-5*
Late completion of the task, shortcomings in paragraph 1	*2-3*
Poor performance of the task	*1*
Task failure	*0*

Modular tests
Weight score – 15 points. The maximum number of points for all tests is equal to: 15 points x2 papers = 30 points
Test evaluation criteria

Completeness and signs of response	*Points*
Full answer	*14-15*
The answer does not provide secondary or dependent on the main parameters (materials)	*10-13*
The answer does not provide half of the major and several minor parameters or materials	*6-9*
The answer is superficial without analyzing parameters, conditions, materials, facts, incomplete conclusions	*1-5*
Test paper not credited	*0*

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

$$R_c = 3 \cdot 7 + 7 \cdot 7 + 15 \cdot 2 = 100 \text{ points}$$

According to the results of educational work for 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 academic 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 amount of points is 100. To obtain a credit from the credit module "automatically" you need to have a rating of at least 60 points.
A prerequisite for admission to the standings is a rating of at least 40% of the rating scale (R), i.e. 40 points.
Students who score less than 0.6 R during the semester, as well as those who want to increase the overall rating, perform credit tests. In this case, all points received by them during the semester are canceled. The tasks of the test paper contain questions that relate to different sections of the credit module. The list of credit questions is given in Chapter 9.

*To obtain a credit grade, the sum of all rating points **R** received during the semester is translated according to the table:*

Score	***Score***
95... 100	*Perfectly*
85... 94	*very good*
75...84	*well*
65... 74	*Satisfactory*
60...64	*enough*
RD 60<	*Disappointing*
Not met the conditions of admission	*not admitted*

11. Additional information on the discipline (educational component)

Sample list of questions submitted for semester control

1. *Give basic concepts and definitions of membrane methods.*
2. *Do an analysis of the selectivity and performance of membranes.*
3. *Give a classification of membranes.*

4. *Describe the main types and methods of obtaining membranes.*
5. *Provide filter and reflection coefficients.*
6. *Compare baromembrane processes.*
7. *Describe the process of nanofiltration.*
8. *Describe the ultrafiltration process.*
9. *Describe the method of reverse osmosis.*
10. *Give the basic concepts and definitions of the adsorption method.*
11. *Describe the existing adsorbents*
12. *Define the length of the working layer of the adsorbent, the unused layer of the adsorbent.*
13. *Give the basic concepts and definitions of the ion exchange method.*
14. *Present the forms of ionites and methods for their regeneration.*
15. *Describe ion exchange materials.*
16. *Give a classification of ionites.*
17. *Give the requirements for the quality of ion exchange membranes.*
18. *Give a classification of destructive methods of water purification.*
19. *Justify the use of oxygen in water purification.*
20. *Substantiate the oxidation of organic impurities with chlorine and its compounds.*
21. *Justify the use of ozone in water purification.*
22. *Justify the use of hydrogen peroxide, manganese compounds in water purification.*
23. *Explain the mechanism of oxidation of impurities in water with oxygen.*
24. *Describe thermo-oxidative methods of water purification.*
25. *Describe the mechanism of deep oxidation of impurities in water.*
26. *Describe liquid-phase oxidation.*
27. *Describe the electrochemical oxidation of impurities in water.*
28. *Describe radiation methods of water purification.*

Work program of the discipline (syllabus):

Compiled by *Assoc., Ph.D., Trus I.M.*

Approved *by the Department of E and PPT (protocol № 14 from 05.18.2023)*

Approved *by the methodological commission of the*

Faculty of Engineering and Chemistry (protocol № 10 from 05.26.2023)