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

Ecology and Plant polymers technology

Water supply and drainage of the most water-intensive enterprises

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	*full-time/remote/mixed*
Year of training, semester	*4th year/8th semester*
Scope of the discipline	*4 ECTS credits (120 hours)*
Semester control/ control measures	*Test*
Lessons schedule	*8 hours per week (2 hours of lectures, 2 hours of practical classes and 4 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=7227*

Program of educational discipline

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

Today, in conditions of scarcity of water resources, the rational use of water is one of the most necessary conditions for economic activity. At the same time, not only the volume of water taken from the environment, but also the volume of polluted effluents released into the environment is extremely important for the state of the hydrosphere. Therefore, a timely assessment of the state of water supply systems and the implementation of safe, modern drainage systems guarantees conditions for the sustainable development of mankind, and the study of relevant disciplines in this field is even necessary. Modern water-intensive enterprises consume huge volumes of water. The rational use of these resources is an important task. The water management of each industrial enterprise has specific features of water use, its sources of pollution and, therefore, requires the development and implementation of specific technological solutions to the problem of water purification for the purpose of its reuse.

The goal of the educational discipline is the formation of students' complex knowledge related to the organization of water supply and drainage systems of industrial facilities for qualified management of technological processes.

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

- *the ability to use the theoretical fundamentals of ecology, environmental protection and sustainable nature management, the 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 human health and the quality of the environment;*

- *the ability to design and implement technologies for purification and processing of exhaust gases, wastewater and solid waste.*

According to the requirements of the program of the educational discipline ***" Water supply and drainage of the most water-consuming enterprises "*** *, students after learning it must demonstrate the following learning outcomes :*

- *to understand the basic environmental laws, rules and principles of environmental protection and nature management;*
- *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 develop and implement projects related to chemical production technologies and equipment, taking into account objectives, resources, existing constraints, social and economic aspects and risks.*

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

The study of the discipline ***"Water supply and drainage of the most water-consuming enterprises"*** *is based on the principles of integration of various knowledge received by students during the three years of the bachelor's degree when studying natural and engineering disciplines. The discipline "* ***Water supply and drainage of the most water-intensive enterprises****" is a fundamental basis that should ensure the solution of complex problems in the field of hydrosphere protection, rational use of water resources and is aimed at a deep rethinking of existing and creation of new integral knowledge and professional practice. The discipline "* ***Water supply and drainage of the most water-intensive enterprises*** *" ensures the implementation of the bachelor's project .*

3. Content of the academic discipline

Chapter 1. Water supply in industry and improvement of water quality.

Topic 1 Peculiarities of water use in industrial production.
Topic 2. Industrial water supply systems.
Topic 3. Basic principles of creating closed water supply systems for industrial enterprises.

Chapter 2. Drainage and wastewater treatment.

Topic 4 . Industrial wastewater.
Topic 5. Features of water drainage systems of industrial enterprises
Topic 6. Treatment of waste water for reuse in production.
Topic 7. Water supply and drainage of enterprises that are the largest consumers of water. Part 1.
Topic 8. Water supply and drainage of enterprises that are the largest consumers of water. Part 2.

4. Educational materials and resources

Basic literature

1. *Shablii T.O., Radovenchyk V.M., Gomelya M.D. Application of new reagents and technologies in industrial water consumption. K. Infodruk , 2014. – 327 p.*
2. *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.*
3. *Shadura V.O., Kravchenko N.V. Water supply and drainage: a study guide.- Rivne: NUVHP, 2018.- 343 p.*
4. *Prutskov D.V., Sokolnyk V.I., Dobrovolska O.G., Kolyada V.P., Vasylenko T.G., Chyganov S.L., Svitlichna V.B. Water supply and drainage of industrial enterprises: Study guide. – Zaporizhzhia: ZDIA Publishing House, 2018. – 194 p.*
5. *Gomelya M.D., Radovenchyk V.M., Shablii T.O. Modern methods of conditioning and water purification in industry. - K.: Graphics, 2007. - 193 p.*

Additional literature

6. *Hayrapetyan T. S., Lukashenko S. V. Industrial water treatment : lecture notes. – Kharkiv: XNUMX named after O. M. Beketova , 2024. - 181 p.*

7. *Technology and equipment for obtaining drinking and technical water: Workshop (Part 2). [Electronic resource]: study guide for students . specialty 161 "Chemical technologies and engineering", specialization "Chemical technologies of inorganic substances and water treatment" / N.M. Tolstopalova , M.I. Litynska , T.I. Obushenko , I.M. Astrelin , O.V. Sanginova; KPI named after Igor Sikorsky - Electronic text data (1 file: 8.12 MB). – Kyiv: KPI named after Igor Sikorskyi, 2020. – 181 p.*
8. *Khilchevskiy V.K., Zabokrytska M.R., Stelmakh V.Yu. Hydro-ecological aspects of water supply and drainage: training . manual. - K.: DIA, 2023. - 228 p.*
9. *Stepova O. V., Trokhymenko H. G. Technologies for the protection of the aquatic environment: a teaching and methodical guide for specialties 101 "Ecology", 183 "Technologies of environmental protection" of all forms of education. Poltava: Poltava Polytechnic University named after Yury Kondratyuk; Mykolaiv: Admiral Makarov National Shipbuilding University, 2022. – 306 p.*
10. *Moshel M.V., Shevchenko O.O. Rational use and protection of water resources: Study guide. - Chernihiv: ChDIEU, 2021. - 365 p*
11. *Epoyan S. M., Ayrapetyan T. S. Return and non-flow systems of water use of industrial enterprises - Kharkiv: XNUMX named after O. M. Beketova, 2022. - 113 p.*
12. *Sashko V. O., Tereshchenko T. M. Water supply. Tutorial. - GURT Resource Center, 2019. - 114 p.*
13. *Tzeitlin M. A., Rayko V. F., Shestopalov O. V. Engineering systems of water supply and drainage of settlements and enterprises: training . help - Kharkiv: FOP Panov A.M., 2022. - 118 p.*
14. *V. G. Petruk, I. V. Vasylkivsk , R. V. Petruk, G. V. Sakalova , and others. Environmental protection technologies. Part 2. Wastewater treatment methods: textbook. – Kherson: Oldi-plus , 2019. - 298 p.*

Information resources on the Internet

15. *Interactive map of river pollution in Ukraine - https://texty.org.ua/water/*
16. *State Agency of Water Resources of Ukraine - https://www.davr.gov.ua/*
17. *National Library named after V.I. Vernadsky - http://www.nbuv.gov.ua/*
18. *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. Water supply to industry and improvement of water quality.	
1	***Topic 1. Features of water use in industrial production.*** *Characteristics of water consumption at the enterprise. The main directions of water use for production needs. Requirements for the quality of water used in industrial processes.* *Literature: [3]; [4]; [6]; [8]; [10].* *Tasks on the IWS: Main indicators of water resource use by enterprises of various industries in Ukraine .*	***2***
2	***Topic 2. Industrial water supply systems and schemes.*** *Water supply schemes for settlements. Schemes of water supply of production facilities. Rational use of water at industrial enterprises.* *Literature: [3]; [4]; [9] ; [12]* *Tasks on the IWS: Sources of water supply for industrial enterprises and their characteristics.*	***2***
3	***Topic 3. Basic principles of creating closed water supply systems for industrial enterprises.*** *Organization of circulating water supply systems. Protection of water circulation systems against scale formation , corrosion and biofouling . Preparation and stabilization of water for circulating systems.* *Literature: [1]; [2] ; [4]; [5]; [6]; [11]* *Tasks on the IWS: Water losses in return systems. Water and salt balances of reverse systems.*	***2***
	Section 2. Drainage and wastewater treatment *.*	
4	***Topic 4. Industrial wastewater.*** *Classification of wastewater discharged from industrial enterprises. Composition of pollutants and properties of industrial wastewater. Conditions of acceptance into the city sewer and conditions of discharge of wastewater into reservoirs.* *Literature: [4] ; [9]; [13] .* *Tasks on the IWS: Necessary the degree of purification of production wastewater for*	***2***

	release them into the sewer or natural reservoirs	
5	***Topic 5. Features of water drainage systems of industrial enterprises*** *Water drainage systems. Separate and combined drainage. Types of treatment facilities are located at industrial enterprises.* *Literature: [3]; [4]; [8] ; [10] .* *Tasks on the IWS: Withdrawal surface storm runoff from territory industrial enterprises . Ways and methods cleaning surface runoff.*	***2***
6	***Topic 6. Treatment of waste water for reuse in production.*** *Conditions for reuse of wastewater in industry. Methods of industrial wastewater treatment. Examples of technological schemes for industrial wastewater treatment. Treatment and disposal of sewage sludge.* *Literature: [4]; [5] ; [9]; [10]; [14] .* *Tasks on the IWS: Cleaning industrial dropped from using chemically active reagents .*	***2***
7	***Topic 7. Water supply and drainage of enterprises that are the largest consumers of water. Part 1*** *Peculiarities of water supply and drainage of heat and power enterprises. Water supply and wastewater treatment of galvanic production.* *Literature: [2]; [5] ; [6]; [7] .* *Tasks on the IWS: Wastewater treatment of ion exchange filters for water reuse.*	***2***
8	***Topic 8. Water supply and drainage of enterprises that are the largest consumers of water. Part 2.*** *The water cycle of enterprises producing soft drinks. Water supply and wastewater treatment of pulp and paper production.* *Literature: [2]; [5] ; [6]; [7] ; [15] .* *Tasks on the IWS: Modern technologies reagentless water lighting .*	***2***
9	***Test***	***2***
	Total hours	***18***

Laboratory classes

In the system of professional training of students, laboratory classes occupy 50 % 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.	***The name of the laboratory work***	***Hours***
1	*Introduction. Instruction on safety techniques, familiarization with the program of laboratory work, issuing of methodical literature.*	***2***
2	*Determination of the corrosion rate of metals in various environments by the massometric method.*	***6***
3	*Stabilizing water treatment in relation to scale formation .*	***6***
4	*Withdrawal ions iron from mordants solution in*	***6***
5	*Cementation of copper in spent electrolytes.*	***6***
6	*Receiving pigments from used ones copper-containing electrolytes .*	***6***
7	*Final lesson*	***4***
	Total hours	***36***

Practical classes

In the system professional preparation students according to this discipline practical occupation occupy 25% of the classroom load . As a supplement to the lecture course, they laid down and formed foundations bachelor's qualifications in ecology , namely protection reservoir from anthropogenic influence . Content of Art these classes and their methods carrying out should provide development

creative activity personality . They develop scientific thinking and ability use special terminology , allow verify knowledge Therefore, this type of work stands out important means operational reverse connection Practical occupation should perform not only cognitive and educational functions , but also to contribute growth students as creative employees in region protection natural environment .

The main ones tasks of the cycle of practical classes:

- to teach students receptions solution practical tasks , to contribute mastery skills and abilities implementation calculations , graphic and others species tasks ;

- to teach their work with scientific and reference literature , documentation and schemes;

- to form skill to learn independently , that is master methods, methods and techniques self-learning , self-development and self-control.

No.	**The name of the practical work**	**Hours**
1	*Introduction: Familiarization with RSO. Obtaining assignments for practical work. Literature: https://do.ipo.kpi.ua/course/view.php?id=7227*	***2***
2	*Practical work 1. Determining the amount of irreversible water consumption in production. Literature: [11];*	***4***
3	*Practical work 2. Calculation of the water balance of circulating water supply systems. Literature: [11];*	***4***
4	*Practical work 3. Determination of the necessary degree of purification of industrial wastewater. Literature: [11];*	***4***
5	*Practical work 4. Selection of a technological scheme of water purification. Literature: [11];*	***4***
6	*Performing a modular test.*	***2***
	Total hours	***18***

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. Water supply to industry and improvement of water quality.		
1	*The main indicators of the use of water resources by enterprises of various industries in Ukraine . Sources of water supply for industrial enterprises and their characteristics. Water losses in return systems. Water and salt balances of reverse systems. Criteria for evaluating the efficiency of water use at enterprises.* ***Literature: [3]; [4] ; [6]; [8] ; [9] ; [11] ; [12] .***	***16***
Section 2 . Drainage and wastewater treatment .		
2	*Necessary the degree of purification of production sewage for release them into the sewer or natural reservoirs Withdrawal surface storm runoff from territory industrial enterprises . Ways and*	***24***

	methods cleaning surface runoff. *Cleaning industrial dropped from using chemically active reagents in* *Types of control and requirements for the quality of feed and boiler water, water of open and closed heat supply systems.* *Wastewater treatment of ion exchange filters for water reuse.* *Modern technologies reagentless water lighting .* ***Literature: [2]; [5] ; [6]; [7] ; [10] ; [14] ; [15] .***	
3	***Preparation for a modular test***	***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*
To understand the basic environmental laws, rules and principles of environmental protection and nature management.	*Lecture 1. Topic 1. Features of water use in industrial production.* *Lecture 2 . Industrial water supply systems .* *Lecture 4. Industrial wastewater.*	*Practical lesson 1. Determination of irreversible water consumption in production.* *Practical lesson 2.* *Calculation of the water balance of circulating water supply systems.* *Practical lesson 3.* *Determination of the necessary degree of purification of industrial wastewater.*
To develop and implement projects related to chemical production technologies and equipment, taking into account objectives, resources, existing constraints, social and economic aspects and risks.	*Lecture 3. Basic principles of creating closed water supply systems for industrial enterprises.* *Lecture 5. Features of water drainage systems of industrial enterprises* *Lecture 6 . Reuse of wastewater for industrial needs.* *Lecture 7. Water supply and drainage of enterprises that are the largest consumers of water . Part 1.* *Lecture 8. Water supply and drainage of enterprises that are the largest consumers of water. Part 2.*	*Practical lesson 4.* *The choice of technological scheme of water purification.*
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.		*Laboratory lesson 1.* *Determination of the corrosion rate of metals in various environments by the massometric method.* *Laboratory lesson 2.* *Stabilization treatment of water in relation to scale formation .* *Laboratory session 3. Extraction of iron ions from pickling solutions.* *Laboratory session 4.* *Cementation of copper in spent electrolytes.*

		Laboratory lesson 5. *Production of pigments from spent copper-containing electrolytes.*

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*
  - *https://www.coursera.org/learn/sustainable-urban-water-systems*
  - *https://www.coursera.org/learn/water-management*
  - *https://www.coursera.org/learn/new-paradigms-in-wastewater-management#about*

  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	Study time		Distribution of study hours				Control measures		
	Credits	Acad. hours	Lectures	Practical	Lab. woks	IWS	MCT	HSW	Semester control
8	4	120	18	18	36	48	1	-	Test

A student's discipline rating consists of the points he receives for: *writing modular control work, performance of laboratory work and practical work classes*
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 5 laboratory works are provided. The maximum number of points for performing laboratory work is equal to:

10 points x 5 l.r. = 50 points

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.	*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 on time, during the defense the student shows insecurity, shows weak knowledge of work issues, 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*

Work on practical classes :

Weighted score for performance counting on practical ones classes - 5 points . Maximum number points : 5 points x 4 answers = 20 points

Criteria assessment implementation calculation

Completeness and signs of response	*Points*
Calculation done completely without errors, the conclusions are given .	*5*
Calculation performed completely , bridge it minor errors , conclusions are given .	*4 - 3*
Calculation not fully completed without errors, the conclusions are given .	*3 - 2*
Calculation not fully completed , contains errors, no conclusions are given .	*2 - 1*
Practical work is not included	*0*

Modular control works

Weighted score - 1 5 points. The maximum number of points for all test papers is equal to:

1 5 points x2 works = 30 points

Evaluation criteria of control works

Completeness and signs of response	*Points*
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 5 + 5 4 + 1 5 2 = 100 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 - practical, laboratory and MKR, while the rating must be at least 40% of 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. *Water supply systems of industrial enterprises.*
2. *Types of water consumption in production.*
3. *Water supply standards.*
4. *What requirements apply to the quality of cooling water?*
5. *What are the requirements for the quality of water used in circulating systems*
6. *technical water supply.*
7. *Existing schemes of water use at industrial enterprises.*
8. *Continuously rotating water supply systems. Their advantages over direct current systems.*
9. *How do closed water supply systems differ from circulating systems?*
10. *What is the essence of rational use of water?*
11. *The water-salt balance equation.*
12. *Use of the concentration coefficient of highly soluble salts for calculations of the hydrochemical mode of operation of circulating water supply systems.*
13. *Causes and types of fouling of pipes and heat exchangers.*
14. *The concept of water stability, the equation of carbon dioxide balance.*
15. *. Methods of water treatment to prevent carbonate deposits, corrosion of pipes and heat exchangers.*
16. *The main reasons for the violation of the water-chemical regime of operation of the existing water supply and drainage systems of the PP.*
17. *Water stability and methods of its provision.*
18. *Name the main methods of preventing dense salt deposits in circulating water supply systems.*
19. *What methods of preventing salt deposits are used in water supply systems.*
20. *The main consumers of water at the TPP.*
21. *Give a diagram of a condensing power plant. Give the water cooling scheme at the TPP.*
22. *Methods of industrial wastewater treatment.*
23. *Technological schemes of wastewater treatment for reuse in production.*
24. *State the requirements for the quality of water used in the production of various types of paper.*
25. *Requirements for the quality of water used in galvanic production.*
26. *The main technological processes and structures used in the preparation of water at TPPs.*
27. *What determines the choice of water treatment method?*

28. The task of preliminary water purification.
29. Preparation of water for the production of alcoholic and non-alcoholic beverages.
30. . Drains water treatment plants and their impact on the environment.
31. Local and plant-wide facilities for water purification.
32. Sewage-free methods of softening by cationization with recovery and reuse of wastewater.

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)*