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

Ecology and technology of plant polymers

Resource efficient use of water resources
Work program of the discipline (Syllabus)

Requisites of the discipline

Level of higher education	***First (bachelor's)***
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	*3rd year/5th semester*
Scope of discipline	*4 ECTS credits (120 hours)*
Semester Control/ Control Measures	*Passed*
Schedule of classes	*4 hours per week (1 hour of lecture and 3 hour lab classes)*
Language of instruction	*Ukrainian*
Information about the course /teachers	*Lecturer: 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*

The program of the discipline

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

The problem of providing the population of our planet with quality drinking water is one of the most acute global environmental problems. The modern existence of mankind cannot be imagined without the use of significant volumes of water both for their own needs and the needs of various industries. It is known that due to the uneven distribution of freshwater resources, more than 40 countries of the world are experiencing a significant shortage of it. A fifth of the population of Europe and America drinks water, the quality of which does not meet modern international standards.

The subject of the discipline "Resource Efficient Use of Water Resources" *is the implementation of approaches that will provide high-quality treatment of natural waters, reliable wastewater treatment, sludge dewatering for the complete transition of industrial enterprises to the use of drainless (closed) water consumption systems.*

Therefore, specialists dealing with the problems of protecting natural water bodies from pollution should have a high level of knowledge of modern methods of water treatment, both for communal needs, including drinking water and water for heat and energy supply, and for industry and energy. They should know all modern methods of wastewater treatment of any origin. It is this knowledge that will allow them to organize resource-saving water consumption systems, to reliably protect water bodies from pollution.

The purpose of the discipline "Resource efficient use of water resources"

The purpose of studying the discipline "Resource Efficient Use of Water Resources" is to form students' complex of knowledge in the field of modern physical and chemical methods of water purification, a set of skills and abilities necessary for conducting research in this direction, for creating resource-saving environmentally friendly technologies for water treatment and wastewater treatment, for qualified management of existing technological processes.

In accordance with the goal, the preparation of bachelors in this specialty requires the formation of students' competencies:

- *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 the natural sciences.*

*According to the requirements of the program of the discipline "**Resource Efficient Use of Water Resources**", students after mastering it must demonstrate the following program learning outcomes:*

- *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;*
- *conduct laboratory tests using modern devices, ensure sufficient measurement accuracy and reliability of results, process the results obtained.*

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 "**Resource Efficient Use of Water Resources**" is based on the principles of integration of various knowledge gained by students during undergraduate studies in the study of disciplines of natural and engineering and technical direction: "Hydrology", "Chemistry with the basics of biogeochemistry", "Special sections of biogeochemistry", "Biogeochemistry", "Organic chemistry", "Analytical chemistry". Discipline "**Resource Efficient Use of Water Resources** " is a fundamental basis for the study of 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", "Project of treatment plants and water use systems", "Processes and equipment for water treatment", "Water treatment stations", and ensures implementation bachelor project.*

3. Contents of the course

Section 1. Resource-saving technologies of air conditioning and water purification for industrial water use systems

Topic 1. The impact of water consumption on the state of water resources
Topic 2. Water use in industry
Topic 3. Cooling systems
Topic 4. Water circulation heating systems

Section 2. Resource-saving technologies of mineralized water purification for industrial and domestic needs

Topic 5. Utilization of highly mineralized mine water
Topic 6. The impact of oil and gas production on the condition and quality of water resources.
Topic 7. Obtaining technical and drinking water from mine water
Topic 8. Obtaining fresh water from various sources
Topic 9. Low-waste technologies for utilization of concentrates with the production of useful products

4. Training materials and resources

Basic literature

1. *Resource efficient use of water resources. Lecture notes [Electronic resource] : textbook. persons. for studios. specialty 101 "Ecology", 161 "Chemical technologies and engineering" / KPI them. Igor Sikorsky ; compiled by: I. M. Trus, M. D. Gomel, M. M. Tverdokhleb. – Electronic text data (1 file: 3.74 MB). – Kyiv : KPI them. Igor Sikorsky, 2023. – 161 p. – Title from the screen. https://ela.kpi.ua/handle/123456789/54687*
2. *Gomel M.D., Shabliy T.O., Radovenchyk Ya.V. Physico-chemical bases of water purification processes: textbook. – Kyiv: Condor Publishing House, 2019. – 256 p.*
3. *Radovenchyk Ya.V., Gomelya M.D. Physico-chemical methods of water purification. Textbook. – Kyiv: Condor Publishing House, 2016. – 264 p.*

4. *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.*
5. *Shabliy T.O., Radovenchyk V.M. Gomel M. D. The use of new reagents and technologies in industrial water consumption.- K.: Infodruk, 2014. – 302p.*
6. *Gomel M.D., Radovenchyk V.M. Shabliy T. O. Modern methods of air conditioning and water purification in industry. -K.: Graphics, 2007. – 168 p.*
7. *Resource efficient use of water resources. Laboratory workshop [Electronic resource] : textbook. persons. for studios. specialty 101 "Ecology", 161 "Chemical technologies and engineering" / KPI them. Igor Sikorsky ; compiled by: M. D. Gomel, T. O. Shabliy, Yu. – Electronic text data (1 file: 708.65 Kb). – Kyiv: KPI them. Igor Sikorsky, 2022. – 65 p. - Title from the screen. https://ela.kpi.ua/handle/123456789/50398*
8. *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

9. *Halysh V.V., Trus I.M., Radovenchyk Ya.V., Fleischer G.Yu., Gomelya M.D. Complex technologies of water purification from heavy metal ions: monograph. – Kyiv: Condor Publishing House, 2020. – 152 p.*
10. *Zapolsky A.K. Water supply, drainage and water quality: Textbook. – K.: Vyshcha shk. 2005 – 671 p.*
11. *Trus I.M. Low-waste technologies of water demineralization: monograph. – Kyiv: Condor-Publishing House, 2016. – 250 p.*
12. *Petruk V.G., Severyn L.I., Vasilkovskyi I.V., Bezvozyuk I.I. Environmental technologies. Tutorial. Part 2: Methods of wastewater treatment – Vinnytsia: VNTU, 2014. – 258 p.*
13. *Petruk V.G., Vasilkivskyi I.V., Bezvozyuk I.I., Petruk R.V., Turchyk P.M. Environmental technologies. Tutorial. Part 3: Methods of sewage sludge processing – Vinnytsia: VNTU, 2013. – 324 p.*
14. *WHO, Guidelines for drinking water quality, 4th edition, incorporating the 1st addendum, 2017.*
15. *Trus I. Applications of antiscalantsin circulating water supply systems / I. Trus, M. Gomelya // Journal of Chemical Technology and Metallurgy. – 2023. – № 58, 2. – P. 360-366.*
16. *Trus I. Technology of the comprehensive desalination of wastewater from mines / I. Trus, N. Gomelya, V. Halysh, I. Radovenchyk, O. Stepova, O. Levytska // Eastern-European Journal of Enterprise Technologies. – 2020. –№3/6 (105). – P.21–27. DOI: https://doi.org/10.15587/1729-4061.2020.206443*

Information resources on the Internet

17. *Ministry of Environmental Protection and Natural Resources of Ukraine – https://mepr.gov.ua/*
18. *Professional Association of Ecologists of Ukraine (PAEU) - https://ecolog-ua.com/paeu*
19. *Library. V.I. Vernadsky – www.nbuv.gov.ua*
20. *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, interdependent knowledge on the discipline "Resource Efficient Use of Water Resources", the level of which is determined by the target setting 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 (highlighting 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***
Section 1. Resource-saving technologies of air conditioning and water purification for industrial water use systems		
1	***Topic 1. The impact of water consumption on the state of water resources*** *Water resources of the planet. Water resources of Ukraine. Dynamics of water resources use in Ukraine. Water consumption by utilities, industry and agriculture.* *Literature: [1] p. 5-27; [2] S. 22-29; [4] p. 24-31; [10] p. 42-71* *Tasks on the CPC: Characteristics of surface, ground, underground (artesian) water. Characteristics of water in coastal regions. Fundamentals of ecological-sanitary-hygienic assessment of water quality in surface water bodies. Integral indicator of water quality.*	***2***
2	***Topic 2. Water use in industry*** *The current state in the use of water in industry. Use of water in water circulation cooling systems. Boiler, waterreversible and closed cooling systems. Open and closed cooling systems. The structure of the water circulation cooling system. Water losses in cooling systems.* *References: [1] pp. 2 8-45; [10] pp. 107-128; pp. 634-645* *Tasks on the CPC: Requirements for the quality of process and energy water.*	***2***
3	***Topic 3. Cooling systems*** *The transition from watercirculating to closed cooling systems. Features of modernization of open cooling systems when created withoutdrainlesssystems. Changes in water treatment. The use of stabilizers scale oformation.* *Literature: [1] p. 46-54; [6] S. 25-37; [10] p. 486-488; p. 535-540; [1, 5] p. 360-366* *Tasks on CPC: Factors affecting the effectiveness of membrane water purification*	***2***
4	***Topic 4. Water circulation heating systems*** *Water circulation system sand heat supply. Requirements for water quality in heat supply systems. Energy systems in the production of steam, electricity. Requirements for water quality in power systems.* *References: [1] p. 55-79; [2] pp. 22-37; [4] pp. 20-24*	***2***

	Tasks on the CPC: Classification of pollution by phase-dispersed state	
Section 2. Resource-saving technologies of mineralized water purification for industrial and domestic needs		
5	***Topic 5. Utilization of highly mineralized mine water*** *The problem of formation and utilization of mine water. Features of the formation of mine water in the coalmining industry, in the extraction of iron ore. Characteristics of mine water in these industries. Mine water drainage systems.* *References: [1] p. 80-93; [2] pp. 247-249; [11] pp. 194-208* *Tasks on the CPC: Complex methods of mine water processing*	***2***
6	***Topic 6. The impact of oil and gas production on the condition and quality of water resources.*** *The impact of oil and gas production on the condition and quality of water resources. Features of oil and gas production technologies, technology and primary processing of oil and gas. Characteristics of associated and formation waters. Rules for handling mines in odes in this industry. Monitoring of groundwater and surface waters on the territory of oil and gas production enterprises of Ukraine.* *References: [1] p. 94-111; [6] pp. 73-89* *Tasks on the CPC: Self-purification of natural water bodies within the influence of oil and gas producers*	***2***
7	***Topic 7. Obtaining technical and drinking water from mine water*** *Prospects for the reuse of mine water in the coal industry. Obtaining process water. Prospects for obtaining drinking water from mine water. Technology for dancing and preparation of drinking water in Alchevsk.* *Literature: [1] p. 112-136; [2] p. 238-239; p. 247-249; [11] p. 194-207* *Tasks on the CPC: Requirements for water quality for household and drinking purposes. The main characteristics of the quality of drinking water, their permissible levels. Requirements for the quality of industrial and energy water. Requirements for water quality in agriculture.*	***2***
8	***Topic 8. Obtaining fresh water from various sources*** *Obtaining drinking and industrial water from artesian and other groundwater with increased mineralization and hardness. Use of brackishx waters of estuaries and seawater to produce fresh water.* *References: [1] p. 137-145; [2] pp. 238-249; [10] p. 107-128* *Tasks on the CPC: Ecological and hygienic classification of surface water quality.*	***2***
9	***Topic 9. Low-waste technologies for utilization of concentrates with the production of useful products*** *The main directions and technologies of utilization of concentrates and saline eluates formed during desalination of mine and natural waters. Return of water to the reservoir. Obtaining oxidized chlorine compounds for water disinfection. Getting coagulants.* *Literature: [1] p. 146-160; [2] p. 61-84; p. 224-226; [5] S. 7-85; [1 2] p. 634-641; [1, 6] p. 21-27* *Tasks on the CPC: Processing of sediments of reagent water treatment in the composition of building materials*	***2***
	Just	***18***

Laboratory classes

In the system of professional training of students, laboratory classes occupy 75% of the classroom load. Being a supplement to the lecture course, they lay and form the basis for the qualifications of the organizer of environmental management. 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.

No salary	*Title of laboratory work*	*Hours*
1	*Entry. Safety instruction, familiarization with the program of laboratory work, issuance of methodological literature.*	***2***
2	*Determination of the main indicators of water quality*	***6***
3	*Determination of mineralization of water by massometric and conductometric methods*	***6***
4	*Reagent water softening with traditional reagents*	***6***
5	*Combined reagent water softening*	***6***
6	*Evaluation of the effectiveness of calcium carbonate and sulfate stabilizers*	***6***
7	*Conducting trial coagulation*	***6***
8	*The study of the process of coagulation.*	***12***
9	*Modular test paper*	***2***
10	*Passed*	***2***
	Just	***54***

Providing program results by the components of the educational component

Program result	*Lecture classes*	*Practical and laboratory classes, individual tasks*
Miti choose the best methods and tools for research, data collection and processing.	*Lecture 9. Low-waste technologies for utilization of concentrates with the production of useful products*	*The lab isnot lesson 2. Determination of the main indicators of water quality* *The lab isnot a lesson 3. Determination of mineralization of water by massometric and conductometric methods*
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. The impact of water consumption on the state of water resources* *Lecture 2. Water use in industry* *Lecture 3. Cooling systems* *Lecture 4. Water circulation heating systems* *Lecture 5. Utilization of highly mineralized mine water* *Lecture 6. Impact of oil and gas production on the state and quality of water resources* *Lecture 7. Obtaining technical and drinking water from mine water* *Lecture 8. Obtaining fresh water from various sources*	
Conductlaboratory tests using modern devices, ensure sufficient measurement accuracy and reliability of the results, process the results obtained.		*The lab is not lesson 4. Reagent water softening with traditional reagents Laboratory is not a lesson 5. Combined reagent water softening* *The lab isnot a lesson 6. Evaluating the effectiveness of calcium carbonate stabilizers and sulfates Laboratory isnot a*

		lesson 7. Conducting trial coagulation *The labis not a lesson 8. Study of the coagulation process*

6. Independent work of a student / graduate student

Independent work takes 40% of the time studying the credit module, including preparation for credit. The main task of students' independent work is to master 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 a 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 the latest technologies of air conditioning and water purification, based on the characteristics of water and quality requirements for 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. Resource-saving technologies of air conditioning and water purification for industrial water use systems		
1	*Characteristics of surface, ground, underground (artesian) waters. Characteristics of water in coastal regions. Fundamentals of ecological-sanitary-hygienic assessment of water quality in surface water bodies.* *References: [2] pp. 8-21; [3] c. 9-18; [4] pp. 9-18; [10] pp. 53-66* *Requirements for the quality of industrial and energy water.* *Литература: [2] с. 22-37; [3] с. 18-24; [4] с. 20-24; [10] с. 81-102; с. 528-530.* *Factors (operating pressure, temperature, nature of thesubstances, concentration polarization) affecting the effectiveness of membrane water purification* *Литература: [2] с. 195-221; [3] с. 195-199* *Classification of contaminants by phase-dispersed state* *References: [2] p. 20-27; [3] p. 9-18; [8] p. 1-41*	***18***
Section 2. Resource-saving technologies of mineralized water purification for industrial and domestic needs		
2	*Complex methods of mine water processing* *References: [11] p. 194-208.* *Self-purification of natural water bodies within the influence of oil and gas producers* *References: [6] pp. 73-89.* *Requirements for water quality for drinking purposes. The main characteristics of the quality of drinking water, their permissible levels. Requirements for the quality of industrial and energy water. Requirements for water quality in agriculture.* *Литература: [2] с. 22-37; [3] с. 18-24; [4] с. 20-24; [10] с. 81-102; с. 528-530* *Ecological and hygienic classification of surface water quality* *References: [2] p. 30-38; [3] p. 24-31* *Processing of sediments of reagent water treatment in the composition of building materials* *References: [11] p. 52-59.*	***22***
3	***Preparing for ICR***	***4***
4	***Preparation for the test***	***4***

	Just	***48***

Policy and control

7. Policy of the discipline (educational component)

Rules for 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 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/113424/drinking-water-treatment.html?ref=search_card*

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

- *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 an 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 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

8. 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*		
	Credits	*Acad. year.*	*Lecture*	*Practical*	*Lab. rob.*	*SRS*	*MKR*	*DKR*	*Semester control*
5	*4*	*120*	*18*	*–*	*54*	*48*	*1*	*-*	*Passed*

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 his work in laboratory work, for writing a modular test. Semester control is credit.

System of rating (weight) points and evaluation criteria

Performance of laboratory work.
The weight score for 1 laboratory work is 10 points. Criteria for evaluating the performance of laboratory works

Completeness and signs of the task	*Bali*
The task is fully completed	*10*
Minor deficiencies under paragraph 1	*8-9*
Late completion of the task	*7*
Late completion of the task, shortcomings in paragraph 1	*2-6*
Poor performance of the task	*1*
Task failure	*0*

Modular tests
Weight score – 1.5points. 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	*Bali*
Full answer	*15*
The answer does not provide secondary or dependent on the main parameters (materials)	*12-14*
The answer does not provide half of the major and several minor parameters or materials	*8-11*
The answer is superficial without analyzing parameters, conditions, materials, facts, incomplete conclusions	*1-7*
Test paper not credited	*0*

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

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

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 test 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 test tasks contain 2 questions that relate to different sections of the credit module. For the correct answer to each question, students receive 50 points. Consequently, the maximum number of points for the test test is 50 points 2 = 100 points. System of evaluation of individual questions of credit test.

Completeness and signs of response	*Bali*
Full answer	*47-50*
The answer does not provide a sufficient number of facts, examples, conclusions are not drawn, or some inaccuracies are made;	*21-46*
A partial answer is given, the specific wording of laws and terms is absent or gross mistakes have been made;	*1-20*
The question is not counted or missing	*0*

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 allowed*

9. Additional information on the discipline (educational component)

NFishing list of questions submitted for semester control

1. *Describe inone the resources of the planet.*
2. *Describe inone resource of Ukraine. Suggest solutions to the provision of water to shallow regions.*
3. *Compare withwater consumption by utilities, industry and agriculture.*
4. *Compare incomplete and complete environmental and hygienic assessments of water quality. Give an integral indicator of water quality.*
5. *Bring in therequirements for the quality of technical and energy water.*
6. *Describe thecurrent state of water use in industry.*
7. *Describe theboiler, water circulation and closed cooling systems.*
8. *Bring the structure into the water circulation cooling system. Suggest ways to reduce water loss in cooling systems.*
9. *P clarify the need for anode from watercirculating to closed cooling systems.*
10. *Describe byapplying stabilizers toboiling water.*
11. *Bring to thelasificationof pollution by phase-dispersed state.*
12. *Bring in therequirements for water quality in heating systems.*
13. *Suggestrequirements for water quality in energy systems.*
14. *Suggestomplex methods for processing mine water.*
15. *Describe the formation of mine water and the need for its disposal.*
16. *Explain the impact ofoil and gas production on the condition and quality of water resources.*
17. *Describe the need foronitoringin groundwater and surface water on the territory of oil and gas production enterprises of Ukraine.*
18. *Describe theprospects for obtaining drinking water from mine water.*
19. *Compare the requirements for drinking water quality, industrial and energy water.*
20. *Odescribe themain directions and technologies of utilization of concentrates and saline eluates formed during desalination of shahand natural waters.*

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)