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

Ecology and technology of plant polymers

Water conditioning for industry
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 lectures, 1 hour of practical and 2 hours of laboratory classes)*
Language of instruction	*Ukrainian*
Information about the course /teachers	Lecturer: *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*

The program of the discipline

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

Today, the industry of Ukraine ranks first among water consumers in terms of wastewater volumes. And if municipal wastewater is restored in natural water bodies due to natural self-treatment, then with industrial wastewater everything is much more complicated. They do not just pollute natural water bodies, they cause accumulation in bottom sediments of many highly toxic substances, such as heavy metal ions or products of their hydrolysis, radionuclides, highly toxic organic substances, including those with carcinogenic properties. This is one of the reasons for today's global environmental catastrophe, which is not paid enough attention. What is released into the environment is extremely dangerous. Continuing to pollute aquatic ecosystems is unacceptable. The only way out is the transfer of industrial enterprises to drainless (closed) water use systems. And only highly qualified specialists can do it.

The subject of the discipline "Water conditioning for industry" *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. 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 conditioningfor industry"

The purpose of studying the discipline "Water conditioning for industry" 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 the creation of 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 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 "**Water conditioningfor industry**", students after mastering it mustdemonstrate 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 "Water conditioning for 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", "Biogeochemistry", "Organic chemistry", "Analytical chemistry". Discipline "Water conditioningfor water 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", "Project treatment plants and water use systems", "Processes and equipment for water purification", "Water treatment stations", and provides implementation of a bachelor's project.

3. Contents of the course

Section 1. Water treatment for industrial water supply systems

Topic 1. Water conditioning for cooling systems when using scale stabilizers
Topic 2. Endorheic cooling systems
Topic 3. Heat supply systems in industry and utilities
Topic 4. Preparation of energy water in the application of reagent methods
Topic 5. Preparation of energy water in the application of ion exchange methods
Topic 6. Preparation of desalinated water using membrane methods

Section 2. Reducing the corrosive activity of water for use in industrial water supply systems

Topic 7. Processing of mineralized concentrates
Topic 8. Corrosive activity of water
Topic 9. Deoxygenation of water to reduce the corrosive activity of water

4. Training materials and resources

Basic literature

1. *Water conditioning for industry. 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: 3.34 MB). – Kyiv : KPI them. Igor Sikorsky, 2023. – 155 p. – Title from the screen.* https://ela.kpi.ua/handle/123456789/54686

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. *Water conditioning for 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. Gomel, T. O. Shabliy, V. V. Vember, M. M. Tverdokhleb. – Electronic text data (1 file: 1.07 MB). – Kyiv: KPI them. Igor Sikorsky, 2022. – 58 p. – Title from the screen.* https://ela.kpi.ua/handle/123456789/50452
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.*

Information resources on the Internet

15. *Ministry of Environmental Protection and Natural Resources of Ukraine – https://mepr.gov.ua/*
16. *Professional Association of Ecologists of Ukraine (PAEU) - https://ecolog-ua.com/paeu*
17. *Library. V.I. Vernadsky – www.nbuv.gov.ua*
18. *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 in the discipline "Water Conditioning for Industry", 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 (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. Water treatment for industrial water supply systems	
1	***Topic 1. Water conditioning for cooling systems when using scale stabilizers*** *Water conditioning for cooling systems. The use of stabilizers forboiling and corrosion inhibitors. Sediment stabilizers based on polyphosphates. Features of the structure of inhibitors, risk stabilization mechanism. Phosphate-based sediment stabilizers. Other types of stabilizers. Evaluation of their effectiveness as inhibitors of metal corrosion. Prospects for the transition to drainless systems using sediment stabilizers.* *References: [1] p. 5-16; [6] p. 7-41; [10] p. 486-488, 535-540* *Tasks on CPC: Adjustment of mineralization of desalinated water*	***2***
2	***Topic 2. Endorheic cooling systems*** *Psoftening of water supplied to feed cooling systems. Creation without waste cooling systems. Advantages and disadvantages of using closed cooling towersin cooling systems. Advantages and disadvantagesof re-agent water softeningfor recharge cooling systems.* *References: [1] p. 17-35; [5] p. 86-130* *Tasks on the CPC: The choice of water supply and drainage schemes for industrial enterprises*	***2***
3	***Topic 3. Heat supply systems in industry and utilities*** *Structure and features of the use of heat supply systems in industry and utilities. Protection of systems from sedimentation. Psoftening of water supplied to feed systemsand heat supply. Protection of the heat supply system from corrosion. Sediment inhibitors. Itsefficiency in protecting equipment from corrosion. Adsorption type corrosion inhibitors.* *References: [1] p. 36-56; [5] p. 152-174; [6] p. 7-41* *Tasks on the CPC: Operation of water supply systems*	***2***
4	***Topic 4. Preparation of energy water in the application of reagent methods*** *Preliminary softening of energy water by agent method. Increasing the effectiveness of water softening through the use of coagulants. Reducing the corrosion aggressiveness of lime water when using aluminatein sodium. Correction of alkalinity of limewater. Clarification of limewater.* *Literature: [1] p. 57-67; [2] p. 61-84; [5] p. 7-85; [1 1] p. 8-34*	***2***

	Tasks on the CPC: Lyophilic and lyophobic colloidal systems.	
5	***Topic 5. Preparation of energy water in the application of ion exchange methods*** *Low-waste ion exchange technology of energy water desalination. The use of weakly acidic cations when using water without prior softening. Separation of chlorides and sulfates into anion and exchange filters. Features of the use of mixed filters.* *References: [1] p. 68-89; [2] p. 241-244; [1 1] p. 60-82* *Tasks on the CPC: The use of ion exchange softening and desalting of water in the preparation of drinking, industrial and energy water. Methods of regeneration of ion exchange filters. Recycling of regeneration solutions.*	***2***
6	***Topic 6. Preparation of desaltedwater using membrane methods*** *The use of reverse osmosis for water demolition. Methods of preliminary clarification, discoloration and softening of water by reverse osmosis. Limiting levels of mineralization of water before reverse osmosis, in concentrate. Dependence of the degree of sampling of permiatey on the level of mineralization of the source water and concentrate. Deepe desalting of water after reverse osmosis.* *References: [1] p. 90-103; [2] p. 197-202; [1 1] p. 108-146* *Tasks on the CPC: Dialysis and pervaporation. Getting membranes*	***2***
Section 2. Reducing the corrosive activity of water for use in industrial water supply systems		
7	***Topic 7. Processing of mineralized concentrates*** *Processing of concentrates reverseosmotic water purification. Extraction of sulfates from TIV concentrates. Processing of sodium chloride solutions. Recycling the solutioninto chloride-containing and sulfates.* *References: [1] p. 104-121; [5] p. 218-245* *Tasks on CPC: Concentration of acid and alkali solutions for reuse*	***2***
8	***Topic 8. Corrosive activity of water*** *The dependence of the corrosive activity of water on temperature, level of mineralization, salt composition, aeration intensity. Selection of promising corrosion inhibitors.* *References: [1] p. 122-132; [6] p. 37-47* *Tasks on the CPC: Rational use of water resources*	***2***
9	***Topic 9. Deoxygenation of water to reduce the corrosive activity of water*** *Reducing the corrosive activity of water by its oxygenation. Oxygenation of water on liquid filters. The reagent will not oxygenate the water. The use of catalysts. Combined methods of oxygenation of water.* *References: [1] p. 133-154; [10] p. 319-336* *Tasks on the CPC: The essence of the method of degassing and the field of its application. Solubility of gases in water*	***2***
	Just	***18***

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 the field of ecology, namely the protection of water bodies from anthropogenic influence. 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	***Topic 1. Endorheic cooling systems*** *Psoftening of water supplied to feed cooling systems. The use of stabilizers forboiling and corrosion inhibitors. Creation withoutwaste cooling systems. Prospects for the transition to drainless systems using sediment stabilizers. Advantages and disadvantages of using closed cooling towersin cooling systems. Advantages and disadvantagesof re-agent water softeningfor recharge cooling systems.* *References: [5] p. 86-130* *Tasks on the CPC: The choice of water supply and drainage schemes for industrial enterprises*	***2***
2	***Topic 2. Heat supply systems in industry and utilities*** *Structure and features of the use of heat supply systems in industry and utilities. Protection of systems from sedimentation. Psoftening of water supplied to feed systemsand heat supply. Protection of the heat supply system from corrosion. Sediment inhibitors. Its efficiency in protecting equipment from corrosion. Adsorption type corrosion inhibitors.* *References: [5] p. 152-174; [6] p. 7-41* *Tasks on the CPC: Operation of water supply systems*	***2***
3	***Topic 3. Preparation of energy water in the application of reagent methods*** *Preliminary softening of energy water by agent method. Increasing the effectiveness of water softening through the use of coagulants. Reducing the corrosion aggressiveness of lime water when using aluminatein sodium. Correction of alkalinity of limewater. Clarification of limewater.* *References: [2] p. 61-84; [5] p. 7-85; [11] p. 8-34* *Tasks on the CPC: Lyophilic and lyophobic colloidal systems.*	***2***
4	***Topic 4. Preparation of energy water in the application of ion exchange methods*** *Low-waste ion exchange technology of energy water desalination. The use of weakly acidic cations when using water without prior softening. Separation of chlorides and sulfates into anion and exchange filters. Features of the use of mixed filters.* *References: [2] p. 241-244; [1 1] p. 60-82* *Tasks on the CPC: The use of ion exchange softening and desalting of water in the preparation of drinking, industrial and energy water. Methods of regeneration of ion exchange filters. Recycling of regeneration solutions.*	***2***
5	***Topic 5. Preparation of desaltedwater using membrane methods*** *The use of reverse osmosis for water demolition. Methods of preliminary clarification, discoloration and softening of water by reverse osmosis. Limiting levels of mineralization of water before reverse osmosis, in concentrate. Dependence of the degree of sampling of permiatey on the level of mineralization of the source water and concentrate. Deepe desalting of water after reverse osmosis.* *References: [2] p. 197-202; [11] p. 108-146* *Tasks on the CPC: Dialysis and pervaporation. Getting membranes*	***2***
6	***Topic 6. Processing of mineralized concentrates*** *Processing of concentrates reverseosmotic water purification. Extraction of sulfates from TIV concentrates. Processing of sodium chloride solutions. Recycling the solutioninto chloride-containing and sulfates.*	***2***

	References: [5] p. 218-245 *Tasks on CPC: Concentration of acid and alkali solutions for reuse*	
7	***Topic 7. Deoxygenation of water to reduce the corrosive activity of water*** *The dependence of the corrosive activity of water on temperature, level of mineralization, salt composition, aeration intensity. Reducing the corrosive activity of water by its oxygenation. Oxygenation of water on liquid filters. Reagent oxygenation of water. The use of catalysts. Combined methods of oxygenation of water.* *References: [10] p. 319-336* *Tasks on the CPC: The essence of the method of degassing and the field of its application. Solubility of gases in water*	***2***
8	*Modular test work from sections 1-2*	***2***
9	*Passed*	***2***
	Just	***18***

Laboratory classes

In the system of professional training of students, laboratory classes occupy 50% of the classroom load. Being an addition 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, 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	*Water phosphating (hexametaphosphate, orthophosphate, sodium tripolyphosphate)*	***4***
3	*The effect of temperature on the effectiveness of reagent water softening*	***4***
4	*Ion exchange softening of water*	***4***
5	*Regeneration of cation exchangers during water softening*	***4***
6	*Investigation of the process of clarification of aqueous suspensions on bulk mechanical filters*	***4***
7	*Demanganization of natural waters of underground sources*	***6***
8	*Water purification by flotation.*	***6***
9	*Final lesson*	***2***
	Just	***36***

Providing program results by the components of the educational component

Program result	*Lecture classes*	*Practical and laboratory classes, individual tasks*
Be able to choose the best methods and tools for research, data collection and processing		*Inservice Lesson 1. Endorheic cooling systems* *Inservice Lesson 2. Heat supply systems in industry and utilities* *Inservice Lesson 3. Preparation of energy water in the application of reagent methods* *Inservice Lesson 4. Preparation of energy water in the application of ion exchange methods* *Inservice Lesson 5. Preparation of desalinated water using membrane methods*

		Inservice Lesson 6. Processing of mineralized concentrates *Inservice Lesson 7. Deoxygenation of water to reduce the corrosive activity of water*
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.	*Lecture 1. Water conditioning for cooling systems when using scale stabilizers* *Lecture 2. Endorheic cooling systems* *Lecture 3. Heat supply systems in industry and utilities* *Lecture 4. Preparation of energy water in the application of reagent methods* *Lecture 5. Preparation of energy water in the application of ion exchange methods* *Lecture 6. Preparation of desalinated water using membrane methods* *Lecture 7. Processing of mineralized concentrates* *Lecture 8. Corrosive activity of water* *Lecture 9. Deoxygenation of water to reduce the corrosive activity of water*	
Conduct laboratory tests using modern devices, ensure sufficient measurement accuracy and reliability of results, process the results obtained.		*Laboratory lesson 2. Water phosphating (hexametaphosphate, orthophosphate, sodium tripolyphosphate)* *Laboratory lesson 3. The effect of temperature on the effectiveness of reagent water softening* *Laboratory lesson 4. Ion exchange softening of water* *Laboratory lesson 5. Regeneration of cation exchangers during water softening* *Laboratory lesson 7. Demanganization of natural waters of underground sources* *Laboratory lesson 8. Water purification by flotation*

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. Water treatment for industrial water supply systems		
1	*Adjustment of desalinated mineralization.* *References: [10] pp. 540-542; [11] pp. 138-146.* *Selection of water supply and drainage schemes of industrial enterprises.* *References: [14] pp. 20-25.* *Operation of water supply systems* *References: [10] pp. 54 3-564* *Lyophilic and lyophobic colloidal systems. Conditions of coagulation of lyophobic colloidal systems* *References: [2] p. 38-84; [3] p. 32-41; [8] p. 132-156* *The use of ion exchange softening and desalting of water in the preparation of drinking, industrial and energy water. Methods of regeneration of ion exchange filters. Recycling of regeneration solutions.* *Литература: [2] с. 165-193; [3] с. 130-136; [5] с. 174-196; [10] с. 394-419; [1 1] с. 60-70* *The use of non-porous membranes. Membrane distillation* *References: [2] pp. 195-221; [3] pp. 188-195*	**26**
Section 2. Reducing the corrosive activity of water for use in industrial water supply systems		
2	*Concentration of acid and alkali solutions for reuse.* *References: [11] pp. 179-193.* *Rational use of water resources* *References: [10] pp. 633-657* *The essence of the method of degassing and the field of its application. Solubility of gases in water* *References: [10] pp. 319-321.*	**14**
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	18	36	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 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	Bali

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:

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

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 withthe application ofcypo stabilizers and corrosion inhibitors.*
2. *Characterize ctabilizeram sedimentation based on phosphates.*
3. *Explain the need forcreation withoutsewage cooling systems.*
4. *What are the main advantages and disadvantages of using closed cooling towers in cooling systems.*
5. *P explain what are therisks and disadvantages of reagent water softening for recharge cooling systems.*

6. *Describe the structureand features of the use of heat supply systems in industry and utilities.*
7. *Give ways to protect systems from sediment.*
8. *Describe andinhibitors of corrosion of the adsorption type.*
9. *Increasing the effectiveness of water softening through the use of coagulants.*
10. *Describe the application of aluminatei sodium to reduce the corrosion aggressiveness of lime water.*
11. *Describe the division of anions on anionandexchange filters.*
12. *Low-waste ion exchange technology of energy water desalination.*
13. *Describe the use of reverse osmosis for water demolition.*
14. *Suggest methods of processingand concentrates reverseosmotic water purification.*
15. *Describe ways tooncenter acid and alkali solutions for reuse*
16. *Explain with theallegiance of the corrosive activity of water on temperature and level of mineralization.*
17. *Explain with theallegiance of the corrosive activity of water from the salt composition and the intensity of aeration.*
18. *Give the conditions for water non-oxygenation on liquid filters.*
19. *Describe the advantages and disadvantages of water deoxygenation.*
20. *Describe thecombined methods of water deoxygenation.*

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)