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

Department of Ecology and Plant Polymers Technology

Water Treatment Technologies

Work program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	*The first (educational and professional)*
Branch of knowledge	*16 Chemical and Bioengineering*
Speciality	*161 Chemical Technology and Engineering*
Educational program	*Industrial ecology and resource efficient cleaner technologies*
Status of discipline	*Custom*
Form of training	*full-time/remote/mixed*
Year of preparation, semester	*4th year, autumn semester*
Volume of discipline	*4 ECTS credits (120 hours)*
Semester control/ control measures	*Test*
Schedule of classes	*4 hours a week (1 hours of lectures, 2 hours of laboratory classes and 1 hours of practical classes)*
Language of instruction	*Ukrainian*
Information about kerivnik course / teachers	*Lecturer: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/glushko-olena-volodimirivna.html* *Practical /Seminary: https://ecopaper.kpi.ua/prokafedru/vykladachi/glushko-olena-volodimirivna.html* *Laboratory:https://eco-paper.kpi.ua/prokafedru/vykladachi/ivanenko-olenaivanivna.html*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id=2654*

Program of discipline

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

Water resources are strategic for every state, as they support all spheres of human life and economic activity, determine the development of industry and agriculture, the location of settlements, and the organization of recreation and health improvement. Existing approaches to water use and water consumption cause a significant anthropogenic load on natural water bodies. That is why today Ukraine is characterized by the practical absence of water bodies whose water belongs to the first quality category. A large part of the population is not provided with quality drinking water, and this problem will continue to worsen as the world experiences significant climate change caused by global anthropogenic activity. A significant problem is the outdated water treatment technologies that were designed in the last century and according to a completely different quality and quantity of water sources. The situation is exacerbated every year by the backward strategy of water consumption, especially in the industry, which ranks first in Ukraine in terms of wastewater discharge.

The subject of the discipline «Water Treatment Technologies» *– modern technological approaches to the preparation of drinking and industrial water. Technological methods of implementation and organization of recycling and/or closed water use cycles in industry.*

To a large extent, the solution to this problem will be determined by the level of training of specialists working in the field of environmental protection, including institutions of environmental safety management of the state, scientific institutions and organizations, and enterprises.

To successfully solve the problems of protecting and preserving natural aquatic ecosystems, specialists must be fluent in information, be able to assess the quality of a water supply source; select a water supply source for municipal and industrial needs; be familiar with modern technological methods of improving water quality for drinking and industrial use and understand the principles of organizing recycling and/or closed water use systems.

The purpose of the discipline «Water Treatment Technologies»

The purpose of studying this discipline is to form a set of knowledge in the field of modern water treatment and water purification technologies, a set of skills and abilities necessary for the informed selection and design of water treatment technologies depending on the initial composition of water, as well as the development of resource-efficient industrial water use technologies. In accordance with the goal, the training of bachelors in this specialty requires the development of students' competencies:

- *Knowledge and understanding of the subject area and understanding of professional activity;*
- *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 Water Treatment Technologies program, students must demonstrate the following program learning outcomes after completing the discipline:

- *To correctly use the terminology and basic concepts of chemistry, chemical technologies, processes and equipment for the production of chemicals and materials based on them in professional activities;*
- *To understand the basic environmental laws, rules and principles of environmental protection and nature management;*
- *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;*
- *To make independent decisions at a specific working place in real production conditions in the process of performing various duties.*

2. Prerequisitions and requisition of disciplines (place in the structural and logical scheme of training according to the relevant educational program)

The study of the discipline "Water Treatment Technologies" is based on the principles of integrating the various knowledge gained by students during the three years of their bachelor's degree in the study of natural and engineering disciplines. The discipline "Water Treatment Technologies" is a fundamental basis for solving 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 holistic knowledge and professional practice. The discipline "Water Treatment Technologies" ensures the implementation of the Course Project on Technology and Design of Industrial Production and the Bachelor's Project.

3. Contents of the discipline

Section 1. Water treatment technologies

Topic 1: Technology of water treatment from surface sources. Classical scheme of watertreatment

Topic 2. Water disinfection technologies using reagent and non-reagent methods

Topic 3. Special methods of water treatment. Technologies of water deironing anddemanganization

Topic 4. Water softening technologies

Topic 5: Industrial water supply. Technologies of water desalination and desalination.

Section 2. Wastewater treatment technologies

Topic 6: Organization of water supply at industrial facilities. Principles of creating recycling andclosed water use systems

Topic 7. Classical technology of municipal wastewater treatment

Topic 8: Technological methods and schemes for the removal of heavy metals, chromates,fluorides and cyanides from wastewater

Topic 9. Basic technologies and methods of wastewater treatment containing oil products,phenols, formaldehyde

Topic 10. Technologies of mine water neutralization. Generation and processing of liquidradioactive waste at nuclear power plants

4. Training materials and resources

Basic literature

1. *Гомеля М. Д., Шаблій Т. О., Радовенчик Я.В. Фізико-хімічні основи процесів очищення води: підручник. – К.: Кондор-Видавництво, 2019. – 256 с.*
2. *Іваненко О.І., Носачова Ю.В. Техноекологія: Підручник.- Київ: Видавничій дім «Кондор», 2017.-294 с.*
3. *Радовенчик Я.В., Гомеля М.Д. Фізико-хімічні методи доочищення води. Підручник. – К.: Кондор-Видавництво, 2016. – 264 с.*

Additional literature

4. *Гомеля М.Д., Крисенко Т.В., Омельчук Ю.А. Методи та технології очищення стічних вод: Навч. посіб. / – Севастополь: Інститут ядерної енергії та промисловості, 2012. – 244 с.*
5. *Гомеля М.Д., Радовенчик В.М., Шаблій Т.О. Основи проектування очисних споруд: Навч. посіб. – К.: ТОВ „Інфодрук”, 2013. – 175 с.*
6. *Технологія та обладнання одержання питної та технічної води. Практикум. Частина 1. [Електронний ресурс]: навчальний посібник для студ. спеціальності 161 «Хімічні технології та інженерія», спеціалізації «Хімічні технології неорганічних речовин та водоочищення» / Н.М. Толстопалова, М.І. Літинська, Т.І. Обушенко; КПІ ім. Ігоря Сікорського – Електронні текстові дані (1 файл: 4,00 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2019. – 101 с.*
7. *Орлов В.О. Водопостачання промислових підприємств: навч. посіб. /В.О. Орлов, Л.Л. Литвиненко, А.М. Орлова. - К.: Знання, 2014.-278 с.*
8. *А.К. Запольський, Н.А. Мішкова-Клименко, І.М. Астрелін, М.Т. Брик, П.І. Гвоздик, Т.В. Князькові. Фізико-хімічні основи технології очищення стічних вод: Підручник. – К.: Лібра. 2000 – 551 с.*

Information resources on the Internet

1. *Професійна Асоціація Екологів України (ПАЕУ) - https://pae.com.ua/*
2. *Міністерство захисту довкілля та природних ресурсів України* - https://mepr.gov.ua/
3. *Промислова екологія. Спільнота фахівців-екологів - http://www.eco.com.ua/*
4. *Бібліотека ім. В.І. Вернадського – www.nbuv.gov.ua*

5. *Екологічний портал України – 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 "Modern technologies of air conditioning and water purification", the level of which is determined by the target installation for each specific topic;*
- *providing in the process of lecture creative work of graduate students together with the teacher;*
- *education of postgraduate professional and business qualities and development of their independent creative thinking;*
- *formation of the necessary interest from graduate students and providing direction for independent work;*
- *determination at the current level of science development in the field of modern methods and processes of air conditioning, forecasting development for the coming years;*
- *display of methodological processing of the material (allocation of the main provisions, conclusions, recommendations, clear and adequate to their formulations);*

use for demonstration of visual materials, combining, if possible, them with the demonstration ofresults and samples;

teaching research materials in a clear and high-quality language in compliance with structural and logical relations, explaining all the newly introduced terms and concepts;

- *accessibility for perception by this audience.*

Practical classes

In the system of professional training of graduate students in this discipline, practical classes occupy 25% of the classroom load. Being an addition to the lecture course, they lay and form the foundations of the qualification of doctor of philosophy in the field of ecology, namely the protection of reservoirs from anthropogenic influence. The content of these classes and the methodology of their conduct should ensure the development of 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 graduate students as creative workers in the field of environmental protection.

The main tasks of the cycle of practical classes:

- *helpaspirantssystematize, consolidate deepen knowledgetheoreticcharacter in the field of modern methods and technologies of air conditioning and water purification;*
- *to teach associativesinvention of practical tasks, to promote mastering and skills of performing calculations, graphic and othertasks;*
- *learners to work with scientific and reference literary schemes;*
- *to form the ability to learn independently, that is, to mastermethods, methods of methods of self-study, self-development of self-control.*

Laboratory classes

In the system of professional training of students, laboratory classes take up 50% of the classroom load. As a supplement to the lecture course, they lay the foundation and form the basis of the bachelor's degree in ecology. The purpose of laboratory classes is to develop students' experimental skills, research approach to the subject, and consolidate theoretical material.

6. Independent work of a student/graduate student

Independent work of students takes 40% of the time of studying the credit module. The main task of students' independent work is to master scientific knowledge in the field of designing wastewater treatment plants, effective wastewater treatment technologies, water treatment, design of water recycling and closed water use systems that are not included in the list of lecture topics through personal search for information, formation of an active interest in a creative approach to academic work.

Politics and control

7. Policy of discipline (educational component)

Rules for attending classes and behavior in classes

Attending classes is a mandatory component of assessment. Graduate 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

incentive points can be awarded by the teacher only for the performance of creative works in the discipline or additional online specialized courses with the receipt of a relevant certificate:

- *https://www.coursera.org/learn/water-treatment;*
- *https://cropaia.com/water-treatment-pro/;*
- *https://www.coursera.org/learn/water-management*
- *https://www.coursera.org/learn/water*

However, their amount cannot exceed 10% of the rating scale..

Penalty points within the discipline are not provided.

Deadline and overlay policy

In case of debts in the discipline or any force majeure circumstances, graduate students should contact the teacher through accessible (provided by the teacher) communication channels to solve problematic issues and coordinate the algorithm of actions for working out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the absence of references when using printed and electronic materials, quotes, opinions of other authors. Invalid hints and write-offs when writing tests, conducting classes; passing the credit for another graduate student; copying of materials protected by the copyright system without the permissionof the author of the work.

The policies 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"https://kpi.ua/code.

Policy of academic behavior and ethics

Graduate students should be tolerant, respect the opinion of others, object to formulate 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"https://kpi.ua/code.

8. Types of control and rating system for evaluating learning outcomes (RCOs)

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

Semester	School time		Distribution of training hours				Control measures		
	Loans	acad. H.	Lecture	Practical	Lab. Rob.	IWS	MCT	HCW	Semester control
7	4	120	18	18	36	48	1	1	Test

A student's grade in a credit module is based on the points he or she receives for writing a homework assignment, a module test, completing laboratory work, and working in practical classes.

The semester control is a test.

System of rating (weight) points and evaluation criteria

A student's credit module rating consists of the points he or she receives for:

- writing a module test;

- writing a research paper

- performing laboratory work;

- two reports in practical classes;

The weighting score for the research work is 10 points.

Assessment criteria for the module test

Completeness and signs of response	***Points***
"excellent", complete answer, at least 90% of the required information (complete, error-free solution of the task)	*10-9*
"good", a sufficiently complete answer, at least 75% of the required information or minor inaccuracies (complete solution of the task with minor inaccuracies)	*8- 7*
"satisfactory", incomplete answer, and some mistakes (the task was completed with certain shortcomings)	*6– 4*
"unsatisfactory", the answer does not meet the conditions for "satisfactory"	*3- 0*

he weighting score for the module test is 5 points.

Assessment criteria for the module test

Completeness and signs of response	***Points***
"excellent", complete answer, at least 90% of the required information (complete, error-free solution of the task)	*5*
"good", a sufficiently complete answer, at least 75% of the required information or minor inaccuracies (complete solution of the task with minor inaccuracies)	*4*
"satisfactory", incomplete answer, and some mistakes (the task was completed with certain shortcomings)	*3*
"unsatisfactory", the answer does not meet the conditions for "satisfactory"	*2- 0*

The weighting score for laboratory work is 5. The maximum number of points for laboratory work is equal to: 5 points x 8 semester hours = 40 points. Laboratory course report - 5 points. Thus,

the maximum weighted score for laboratory work is 45.

The necessary conditions for student admission to laboratory work are:

- availability of the protocol of the relevant laboratory work;

- a positive answer to the questions of the incoming express control of the quality of the student's theoretical preparation for the laboratory work (express control is carried out in the form of an oral survey conducted at the beginning of the class). In case of non-compliance with these conditions, the student is not allowed to perform the laboratory work.

Evaluation criteria	***Points***
"excellent" - timely complete completion of laboratory work, calculations based on the data of the experiment, design and defense	*5*
"good" - timely completion of laboratory work, shortcomings in calculations and design	*4-3*
"Satisfactory" - untimely completion of laboratory work, gross errors in calculations and design	*2-1*
"unsatisfactory" - the laboratory work was not completed	*0*

The weighting score for reports at practical classes is 20.

Maximum number of points: 20 points x 2 answers = 40 points

Criteria for evaluating reports

Completeness and signs of response	***Points***
"excellent", the content of the report is fully covered, conclusions are drawn, the report is well presented	*20-18*
"good", the content of the report is not fully covered, conclusions are drawn, an informative presentation is made	*17-15*
"Satisfactory", the content of the report is sufficiently covered, no conclusions are given, the report is not presented	*15-10*
"unsatisfactory", the report does not meet the requirements for "satisfactory"	*< 10*

Thus, the rating scale for the credit module is 100 points

$R = R_{HCW} + R_{MCT} + R_{Iw}. + R_a = 10+5++45+40=100$ *points*

At the first assessment (week 8), a student receives a "pass" if their current rating is at least 20 points. At the second assessment (week 14), a student receives "passed" if his or her current rating is at least 50 points.

A prerequisite for admission to the test is the completion of all laboratory work, passing the module test and reports in practical classes, and a rating of at least 60 points.

Students who have a rating of less than 60 points at the end of the semester, as well as those who want

to improve their ECTS score, take a test. In this case, all previous grades are canceled. The grade for the test is final. The test consists of five questions from different sections of the syllabus. Each question of the test (r_1, r_2, r_3, r_4, r_5) is rated from 0 to 20 points. The sum of points obtained for the semester, or the sum of points for each of the five questions of the test is converted to a final grade 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*
Admission conditions not met	*not allowed*

Work program of the discipline (syllabus):

Compiled by Associate Professor, Candidate of Technical Sciences, Hlushko O.V.

Approved *by the Department E and PPT (protocol No 14 from 18.05.2023)*

According tothe *Methodical Commission*

of the Faculty of Engineering and Chemistry (protocol No 10 from 26.05.23)