Syllabus

educational professional program
Physico-chemical research methods

Subjects:	Physico-chemical research methods
Level of higher education:	third (educational and scientific)
Course page in Moodle:	https://dl.khadi.kharkov.ua/course/view.php?id=1391
The scope of the educational component	4 credits (120 hours)
Final control form	test
Consultations:	on schedule
Name of the department:	Department of Ecology
Teaching language:	English,
Course leader:	Olena Ihorivna Pozdniakova, PhD, associate professor
Contact phone number:	**707-37-41**
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Brief content of the educational component: The goal is to train highly qualified specialists in the field of natural sciences who are able to solve complex environmental problems, conduct original independent scientific research and carry out scientific and pedagogical activities based on the formed general scientific and professional competencies.
Subject: there are dependences of the physical properties of the substance, which are functionally related to the concentration of the component being determined, on its nature, and the intensity of radiation, current strength, electrical conductivity, potential difference, etc. are used as an analytical signal.
The main tasks of studying an academic discipline are:
- mastering the methodology of the basic methods of physical research and their application in the practice of ecological research;
- formation of basic knowledge and ideas about the main methods of research of physico-chemical properties and structure of substances in various environments of ecosystems;
- determination of the characteristics of the most important spectral, electrochemical, chromatographic mass-spectrographic methods, which can be used for the analysis and control of the quality of the environment;

Prerequisites for studying the educational component:
Environmental safety of scientific developments (by branch), environmental protection technology.
Foreign language of scientific communication.

Competencies acquired by the acquirer:

General competences:

The ability to solve complex complex problems in the field of ecology, environmental protection and balanced nature management when carrying out research and innovation activities, which involves a deep rethinking of existing and creating new integral knowledge, mastering the methodology of scientific and scientific-pedagogical activities, conducting independent scientific research, the results of which have scientific novelty, theoretical and practical significance.
Ability to abstract thinking, analysis and synthesis.
Ability to develop and manage projects.
The ability to identify, analyze and solve significant problems using the scientific method of cognition.

Special (professional) competences:

The ability to orally and in writing present and discuss the results of scientific research and/or innovative developments in Ukrainian and English, a deep understanding of English-language scientific texts in the field of research.
Ability to use modern information technologies, databases and other electronic resources, specialized software in scientific and educational activities.
The ability to carry out scientific and pedagogical activities in higher education.
The ability to use modern methods and tools of systematic analysis of the quality of the environment, necessary for conducting scientific research aimed at solving significant problems in the field of ecology, environmental protection and balanced nature management._

Learning outcomes according to the educational program:
Deeply understand the general principles and methods of natural sciences, as well as the methodology of scientific research, apply them in one's own research in the field of ecology, environmental protection and optimization of nature use, and in teaching practice.
Freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of ecology, environmental protection and optimization of nature use in national and foreign languages in compliance with the norms of academic ethics, competently reflect the results of research in scientific publications in leading international scientific publications.
Plan and carry out experimental and/or theoretical research in ecology, environmental protection and optimization of nature use and related interdisciplinary areas using modern tools, critically analyze the results of own research and the results of other researchers in the context of the entire complex of modern knowledge regarding the problem under study.
Develop and implement scientific and/or innovative engineering projects that provide an opportunity to rethink the existing and create new holistic knowledge and/or professional practice and to solve significant scientific and technological problems of environmental protection and optimal use of nature, taking into account social, economic, ecological and legal aspects.
To solve significant scientific and technological problems of environmental protection and optimal use of nature with the application in scientific research of theoretical and methodological aspects of system analysis of environmental quality, modeling and forecasting of changes in the components of ecosystems
Oriented list of topics of qualification papers: Does not have

Teaching methods:
1) verbal: 1.1 traditional: explanation, story, etc.;
1.2 interactive (non-traditional): discussions, etc.;
2) visual: method of illustrations, method of demonstrations
3) practical:
3.1 traditional: consultations;
3.2 interactive (non-traditional): seminars-discuss ions, "round table", brainstorming method.

Thematic plan

№ of topic	Name of topics (LC, LW, PW, SC, IW)	Number of hours	
		intramural	extramural
1	LC. Actual directions of physical and chemical methods of analysis of pollutants in the environment	2	
	PW (LW, IW)		
	IW Development of a methodology for the analysis and identification of pollutants in the environment	6	
2	LC. Chemical-analytical control of environmental quality and safety: titrimetric methods of analysis; gravimetric methods of analysis; chromatographic and chromatographic-mass-spectrometric methods	4	
	PW (LW, IW)		
	IW. Analysis of the results of the electrochemical analysis of the content of heavy metals in the water environment	6	
3	LC. Nephelometry of turbid environments and its application in environmental analysis.	4	
	PW (LW, IW)		
	IW. Analysis of the spectra of substances coming from: road transport; from the waste incineration plant; substances released during various methods of processing materials; of organic compounds found in urban atmospheric air	6	
4	LC. Application of luminescent analysis to determine the quality of environmental objects.	4	
	PW (LW, IW)		
	IW. Analysis of spectra of substances adsorbed on household dust; coming with tobacco smoke; substances found in refrigerating units; substances coming from polymeric materials; substances released by food products.	6	
5	LC. Spectra of pollutants in the water of water bodies	4	
	PW (LW, IW)-		
	IW. Analysis of the spectra of substances found in drinking water, in surface waters of races of packaged water.	6	
6	LC. Spectral analysis of atmospheric pollutants	4	
	PW (LW, IW)		
	IW. Gas chromatographic determination of toluene and its derivatives in a mixture of substances	6	
7	LC. Atomic adsorption analysis of environmental objects.	4	
	PW (LW, IW)		

	IW. Chromato-mass spectrometric determination of polycyclic aromatic hydrocarbons in air.	6	
8	LC. Electrochemical methods of control of organic substances that pollute soils	4	
	PW (LW, IW)		
	IW Chromato-mass spectrometric determination of volatile organic substances in soils and production and consumption waste.	6	
9	LC Chromato-mass spectrometric determination of volatile organic substances in air, soil and water.	6	
	PW		
	IW Assessment of environmental aspects of disposal of electrical and electronic equipment on the example of acid and lithium-ion batteries.	6	
10	LC. Chemical-analytical aspects of assessing the safety and effectiveness of new technologies in environmental hygiene	4	
	PW		
	IW Chemical-analytical aspects of assessing the safety and effectiveness of new technologies in environmental hygiene	6	
11	LC. Assessment of environmental aspects of burning traditional and alternative fuels at stationary power plants	4	
	PW		
	IW. Assessment of environmental aspects of burning traditional and alternative fuels at stationary power plants	6	
12	LC. Mass spectrometric analysis of the quality of petroleum products and spent lubricants	4	
	PW		
	IW. Use of modern methods of evaluation of mass spectrometric analysis in premises and open space.	6	
Разом	LC	48	
	PW (LW, IW)		
	IW	72	

Individual educational and research task: (does not have):

Teaching methods:
1) verbal: 1.1 traditional: lectures, explanations, stories, etc.;
1.2 interactive (non-traditional): discussions, etc.;
2) visual: method of illustrations, method of demonstrations
3) practical: 3.1 traditional: practical classes;
3.2 interactive (non-traditional): discussions.

Evaluation system and requirements:
Current performance
1 The current performance of applicants for the performance of educational types of work in training sessions and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation of current performance, all types of work provided for by the educational program are taken into account.
1.1 Lecture classes are evaluated by determining the quality of performance of specified tasks.

1.2 Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.

2 Evaluation of the current academic performance of students of higher education is carried out at each practical session on a four-point scale ("5", "4", "3", "2") and is entered in the journal of academic performance.

– "excellent": the winner mastered the theoretical material flawlessly, demonstrates in-depth knowledge of the relevant topic or academic discipline, the main provisions;

– "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in a reasoned manner; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;

– "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;

– "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed.

3 The final score for the current activity is recognized as the arithmetic mean sum of points for each lesson, for individual work, current test works according to the formula:

$$K^{поточ} = \frac{K1 + K2 + ... + Kn}{n},$$

де $K^{поточ}$ – final assessment of success based on the results of current control;
$K1, K2, ..., Kn$ – evaluation of the success of the current control measure;
n - the number of measures of current control.

Estimates are converted into points according to the calculation scale (table 1).

Table 1 – Recalculation of the average grade for the current activity into a multi-point scale

4- points scale	100-points scale	4- points scale	100-points scale	4- points scale	100-points scale	4- points scale	100- points scale
5	100	4,45	89	3,90	78	3,35	67
4,95	99	4,4	88	3,85	77	3,3	66
4,9	98	4,35	87	3,80	76	3,25	65
4,85	97	4,3	86	3,75	75	3,2	64
4,8	96	4,25	85	3,7	74	3,15	63
4,75	95	4,20	84	3,65	73	3,1	62
4,7	94	4,15	83	3,60	72	3,05	61
4,65	93	4,10	82	3,55	71	3	60
4,6	92	4,05	81	3,5	70	from 1,78 to 2,99	from 35 to 59
						reassembly	
4,55	91	4,00	80	3,45	69	from 0 to 1,77	from 0 to 34
4,5	90	3,95	79	3,4	68	repeated study	

Final assessment

1 The exam is held after studying all topics of the discipline and is completed by students of higher education during the examination session after the end of all classroom classes

2 Students of higher education who have completed all types of work prescribed by the curriculum in the discipline are admitted to the exam:

- were present at all classroom classes (lectures, seminars, practical);
- completed all missed classes on time;
- scored the minimum number of points for the current academic performance (at least 36 points, corresponding to the national scale "3");

If the current success in the discipline is lower than 36 points, the higher education applicant has the opportunity to increase his current point to the minimum before the beginning of the examination session.

3 Assessment of the knowledge of applicants when taking the exam is carried out on a 100-point scale.

Assessment of the knowledge of applicants through testing is carried out according to the following scale:

- "Excellent": at least 90% of correct answers;
- Very good": from 82% to 89% of correct answers;
- "Good": from 74% to 81% of correct answers;
- "Satisfactory": from 67% to 73% of correct answers;
- "Satisfactory enough": from 60% to 66% of correct answers;
- "Unsatisfactory": less than 60% of correct answers.

4The final grade for the academic discipline is defined as a weighted average grade that takes into account the overall grade for the current academic performance and the grade for passing the exam.

5 The calculation of the overall final grade for the study of an academic discipline is carried out according to the formula:

$$ПК^{екз} = 0,6 \cdot K^{поточ} + 0,4 \cdot E,$$

де $ПК^{екз}$ – final assessment of success in disciplines, the form of final control for which is an exam;

$K^{поточ}$ – final assessment of success based on the results of current control (on a 100-point scale);

E - evaluation based on the results of the exam (on a 100-point scale).

– coefficients of the ratio of points for current success and passing the exam.

6 Additional points are awarded to winners for individual independent work and participation in scientific events.

6.1 Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines for which the final form of control is a credit), or to the final grade for a discipline for which the final form of control is an exam.

6.2 The number of additional points awarded for different types of individual tasks depends on their volume and significance:

- prize places in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;
- prize places in the discipline at the All-Ukrainian Olympiads - 20 points;

– participation in the international / all-Ukrainian competition of scientific student works - 15 points

– participation in international / all-Ukrainian scientific conferences of students and young scientists - 12 points;

– participation in all-Ukrainian Olympiads in the discipline - 10 points

– participation in Olympiads and scientific conferences of the Khnadu in the discipline - 5 points;

– performance of individual scientific and research (educational and research) tasks of increased complexity - 5 points.

6.3 The number of additional points cannot exceed 20 points.

7 The total final grade for studying an academic discipline cannot exceed 100 points. The overall final grade for the study of the academic discipline is determined according to the scale given in Table 2**.**

Table 2 – The scale for evaluating the knowledge of students based on the results of the final control of the academic discipline

<table>
<tr><td rowspan="2">Score in points</td><td colspan="2" rowspan="2">Evaluation on a national scale</td><td colspan="2">Evaluation according to the scale of the European credit transfer-accumulation system</td></tr>
<tr><td>estimation</td><td>Criteria</td></tr>
<tr><td></td><td>examination</td><td>test</td><td></td><td></td></tr>
<tr><td>90-100</td><td rowspan="3">Perfectly</td><td rowspan="3">Enrolled</td><td>A</td><td>The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum</td></tr>
<tr><td>80–89</td><td>B</td><td>The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum</td></tr>
<tr><td>75-79</td><td>C</td><td>The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors</td></tr>
<tr><td></td><td colspan="2">Fine</td><td colspan="2">Enrolled</td></tr>
</table>

Score in points	Evaluation on a national scale		Evaluation according to the scale of the European credit transfer-accumulation system	
			estimation	Criteria
	examination	test		
67-74	**Satisfactorily**		**D**	The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors
60–66			**E**	The theoretical content of the course has been partially mastered, some practical work skills have not been formed, many educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum.
35–59	**Unsatisfactorily**	**Not counted**	**FX**	The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking)
0–34	**Unacceptable**		**F**	The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course).

Course policy:

– the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;

– mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;

– independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;

– all tasks provided by the program must be completed within the set time;

– if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;

– while studying the course, students of higher education must adhere to the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the Khnadu" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Academic Integrity. Checking the text of academic, scientific and qualification papers for plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf), "Moral and ethical code of participants in the educational process of the Khnadu (https://www .khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).

– in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;

– writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

Recommended Books:

1. Posudin Yu. I. Biophysics and methods of environmental analysis: Textbook. / Yu. I. Posudin - K.: 2013. - 354 p.;-bibliography: pp. 342-348.

Посудін Ю. І. Біофізика і методи аналізу навколишнього середовища : Підручник. / Посудін Ю. І. – К.: 2013. − 354 с.;−бібліогр: С. 342−348.

2. Methods of measuring environmental parameters: subject /G. I. Hryn, V. I. Mohonko, O. V. Suvorin, and others. – Severodonetsk: branch of SNU named after V. Dalya, 2019. – 420 p.,

Методи вимірювання параметрів навколишнього середовища: підруч /Г. І. Гринь, В. І. Мохонько, О. В. Суворін та ін. – Сєвєродонецьк : вид-во СНУ ім. В. Даля, 2019. – 420 с.,

3. Tsyganok L.P.C. 94 Analytical chemistry. Chemical methods of analysis: study guide/ L.P. Tsyganok, T.O. Bubel, A.B. Vyshnikin, O.Yu. Vashkevich; Under the editorship Prof. L.P. Tsyganok - Dnipropetrovsk: DNU named after O. Honchara, 2014.-252 p.

Циганок Л.П.Ц 94 Аналітична хімія. Хімічні методи аналізу: навчальний посібник/ Л.П. Циганок, Т.О. Бубель, А.Б. Вишнікін, О.Ю. Вашкевич; За ред. проф. Л.П. Циганок -Дніпропетровськ: ДНУ ім. О.Гончара, 2014.-252с.

4. Nabivanets B.Y. Analytical chemistry of the environment, Kyiv, Lybid, 1996, 423p.

Набіванець Б.Й. Аналітична хімія оточуючого середовища Київ, Либідь, 1996р, 423с.

Adjuvant literature

1. Szeged A. S. Qualitative and quantitative analysis - Lybid, Kyiv, 2003. 246 p.

Сегеда А. С. Якісний та кількісний аналіз - Либідь, Київ, 2003р. 246с.

2. By Seth M. Siegel: Let There Be Water. Source: Yakaboo_Publishing, 2021, 249 p.

Автор Сет М. Сигел: Нехай буде вода. Из-во : Yakaboo_Publishing, 2021р 249с.

https://www.yakaboo.ua/nehaj-bude-voda-izrail-s-kij-dosvid-virishennja-svitovoi-problemi-nestachi-vodi.html

3. Yu.M. Danchenko, T.M. Obizhenko and others. Physico-chemical methods of analysis. Laboratory practice: Educational and methodological guide. - Kh.: Khnuba, 2017. - 57 p.

Ю.М. Данченко, Т.М. Обіженко та ін. Фізико-хімічні методи аналізу. Лабораторний практикум: Навчально-методичний посібник. – Х.: ХНУБА, 2017. – 57 с.

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