NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Departmentof Analytical and Bioinorganic Chemistry & Water Quality

"CONFIRMED"
Dean of the Plant Protection,
the Biotechnologies and Ecology Faculty
(Prof. Yulia Kolomiets)
_____ 2024.

"APPROVED"
at the meeting of the department of analytical
and bioinorganic chemistry & water quality
Protocol № 11 dated "25"05 2024.
Head of Department
_____(Prof. Volodymyr Kopilevich)

"REVIEWED"
Garantor of AP
Ecology Bachelor
(Prof. Volodymyr Bogolyubov)

CURRICULUM OF ACADEMIC DISCIPLINE

CHEMISTRY (INORGANIC AND ANALYTICAL)

Field of knowledges 10 Natural Sciences
Specialization101 - Ecology
Educational program Ecology
Faculty of the Plant Protection, the Biotechnologies and Ecology
Developer:Associate Professor, Cand Chem Sci Larysa Voitenko
(position, academic degree, academic title)

Kyiv – 2024

Description of the discipline

Chemistry (inorganic and analytical)

(назва)

Academic degree, specialty, academic programme		
Academic degree	*bachelor's*	
Specialty	*101- Ecology*	
Academic programme	*Ecology*	
Characteristics of the discipline		
Type	compulsory	
Total number of hours	150	
Number of ECTS credits	5	
Number of modules	4	
Course project (work) (if any)	-	
Form of assessment	*exam*	
Indicators of the discipline for full-time and part-time forms of university study		
	Full-time	Part-time
Year of study	The 1st	-
Semester	The 1st	
Lectures	*60 hours*	
Laboratory classes	*60 hours*	
Self-study	*50 hours*	
Number of hours per week for full-time students	*8 hours*	

1. Aim, objectives, competences and expected learning outcomes of the discipline

Aim is to develop an understanding of the range and uses of inorganic chemistry and analytical qualitative and quantitative methods for the application in monitoring and research of the environmental objects, and formation of skills in chemical experiment performing.

Objectives are to acquire basic concepts, principles, and techniques of modern inorganic and analytical chemistry that would empower students with a chemical mindset and the abilities to solve diverse chemical problems for environmental assessment in an efficient and quantitative way that conveys the importance of accuracy and precision of the analytical results.

Acquisition of competences:

Integral competence (IC): The ability to solve complex specialized problems and solve practical problems in the field of ecology, environmental protection, and sustainable environmental management, which involves the application of basic theories and methods of science about environments that are characterized by complexity and uncertainty of conditions.

General competences (GC):

GC1. Knowledge and understanding of the subject area and professional activity

GC8. Ability to conduct research at the appropriate level

GC10. The ability to evaluate and ensure the quality of performed works.

Special (professional) competences (SC):

SC2. Ability to critically understanding and basic theories, methods and principles of natural sciences.

SC 3. Ability to understand basic theoretical concepts regulations, concepts and principles of natural and of social and economic sciences.

SC7. Ability to monitor and evaluate current condition of environment based on analytical monitoring data.

Expected Learning Outcomes (ELO):

ELO 3. Understand the basic concepts, theoretical and practical problems in the field of natural sciences, which are necessary for analysis and decision-making in the field of ecology, environmental protection and balanced nature management.

ELO 14. Be able to create texts, make presentations and messages for professional audiences and the general public with observance of professional integrity and impossibility plagiarism.

ELO 18. Combine the skills of independent and team work to achieve results with an emphasis on professional integrity and responsibility of or decision-making.

ELO 19. Increase the professional level by continuing education and self-education.

ELO 21. To be able to choose optimal methods and tools for research, collection and data processing.

2. Program and structure of the subject
- for full-time English-speaking students

Modules naming and chapters	Hours						
	Full-time						
	weeks	total	included				
			lectures	Practice training	Lab works	Individual tasks	Independent work
1	2	3	4	5	6	7	8
Module 1. Theoretical Foundations of the Inorganic Chemistry. The General Laws of Chemical Transformations							
Topic the 1st. Chemistry as the science that deals with the properties, composition, and structure of substances	1	5	2		2		1
Topic the 2d. Atomic structure of chemical elements	2	6	2		2		2
Topic the 3d . Periodicity of changes in structure and properties of elements and their compounds	3	5	2		2		1
Topic the 4th. Chemical bonding and molecular structure	3	6	2		2		
Total for content module 1	1-3	22	8		8		6
Module 2.The general laws of chemical transformations							
Topic the 1st. Chemical kinetics and equilibrium	4	5	2		2		1
Topic the 2d. Solutions and their properties. Electrolytes and electrolytic dissociation. Ionic equations.	4	8	3		3		2
Topic the 3rd. Hydrolysis of salts. Notion of a pH	5	8	3		3		2
Topic the 4h. RedOx processes	6-7	10	4		4		2
Topic the 5th. Complex (coordination) compounds	7	9	4		4		1
Total for content module 2	4-7	40	16		16		8
Module 3.Chemistry of elements and qualitative chemical analysis							
Topic the 1st. Subjects and objects of the chemical analysis (analytical chemistry). Methods of quantitative analysis. Subjects of qualitative and quantitative analyses. Methods of qualitative analysis. Analytical reactions and requirements to analytical reactions.	8	6	2		2		2

1	2	3	4	5	6	7	8
Topic the 2d. Chemical-analytical properties of the cations on the examples of s-elements belongs to IA and IIA groups, p-elements belongs to IIIA and IVA groups, and d-elements of the IIIB and VB groups.	8-9	16	7		7		2
Topic the 3rd. Chemical-analytical properties of the cations on the examples of p-elements belongs toVIIA, VIA, VA, and IVA groups. Qualitative analysis of inorganic substances (salts, acids, bases, oxides).	10-11	16	7		7		2
Total for content module 3	8-11	38	16		16		6
Module 4.Theoretical and experimental foundations of the quantitative chemical analysis							
Topic the 1st. Equilibrium in heterogeneous and homogeneous systems. Precipitation and sediment dissolving reactions; their application for qualitative and quantitative analysis	12	10	4		4		2
Topicthe th 2d. Theoretical foundations of measurement and processing of results in chemical analysis. The essence and task of quantitative measurements and calculations.	12	10	4		4		2
Topic the 3rd. Titrimetric methods of quantitative analysis (volumetry). The application of volumetric methods in environmental analysis. Neutralization method.	13	10	4		4		2
Topic the 4th. RedOxmetry in quantitative analysis.	14	10	4		4		2
Topic the 5th. Complexonometry in quantitative analysis.	15	10	4		4		2
Total for content module4	12-15	50	20		20		10
Total hours:	**1-15**	**150**	**60**		**60**		**30**

3. Topics of laboratory classes

#	Topic title	Hours
1	2	3
1	Introduction. Lab Safety rules. Semimicro qualitative lab techniques. The introduction testing. General chemical properties of main classes of inorganic substances. Chemical name Calculator application (https://www.omnicalculator.com/chemistry/chemical-name)	2
2	Electron formulas compiling. Determination of valence and oxidation number of the chemical elements as a function of their electron configuration. Electron configuration simulation (i.e., https://www.wolframalpha.com/widgets/gallery/view.jsp?id=bd4637e2261cbcdda20d9077e61c712f&reportprob=1)	2
3	Periodicity as an expression of electron shell structures. Visualisation of the periodicity (i.e., https://www.behance.net/gallery/46554621/Visualizing-the-Periodic-System-of-Chemical-Elements)	2

1	2	3
4	Qualitative assessment of chemical bonding types and molecular structure of acids, bases, salts, oxides. Virtual simulation of chemical bonds and visualization of molecules (i.e. "Avogadro" tool https://sourceforge.net/projects/avogadro/files/avogadro/)	2
5	Experimental studding of strong and weak electrolytes from viewpoint of Avogadro's electrolytic dissociation theory. How to compile the ionic equations. How to use the net ionic calculator (i.e.,https://www.chemicalaid.com/tools/netionicequation.php?hl=en).	2
6	Experimental studding of hydrolysis of salts in water medium. How to predict and to measure of a pH. How to use a Hydrolysis calculator (i.e., https://www.calculatoratoz.com/en/anionic-salt-hydrolysis-Calculators/CalcList-2611).	3
7	Experimental studding of RedOx processes; chemical nature of Reducing and oxiding agents. RedOx potential and its measuring in water medium. Electron balance and half-reaction methods. How to use a RedOx calculator (i.e., https://calculator-online.net/redox-reaction-calculator/).	3
8	Experimental studding of complexing processes. How to isolate and decompose the coordinative compounds. IUPAC nomenclature of coordinate compounds (https://unacademy.com/content/jee/study-material/chemistry/iupac-nomenclature-of-coordination-compounds/)	4
9	Introduction to qualitative analysis. The action of general group reagents on metal cations.	1
10	Studding of chemical-analytical properties and qualitative tests of s-element cations (on the example of Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}) and ammonia cation NH_4^+.	3
11	Studding of chemical-analytical properties and qualitative tests of p-element cations (on the example of Al^{3+}, Pb^2).	4
12	Studding of chemical-analytical properties and qualitative tests of d-element cations (on the example of Zn^{2+}, Cu^{2+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Ag^+).	3
13	Studding of chemical-analytical properties and qualitative tests of anions belongs to p-elements of VIIA, VIA, VA, IVA and IIIA groups (on the example ofB^{3+}, C^{4+}, Si^{4+}, N^{3+}, N^{5+}, P^{5+}, O^{-1}, S^{4+}, S^{6+}, Cl^-, Br^-, I^-	3
14	Analytical classification of the main bioactive cations. Separation and identification of I-IV cation groups according to the ammine-phosphate classification.	2
15	Analytical classification of the main bioactive anions. Separation and identification of anions SO_4^{2-}, SO_3^{2-}, CO_3^{2-}, PO_4^{3-}, Cl^-, Br^-, I^-, NO_2^-, NO_3^-.	2
16	The identification methods of the inorganic substances qualitative analysis. Two experimental control tasks for the analysis of chemical parameters.	4
17	Experimental strategies of quantitative analysis: weighing, measuring vessels, filtering. Volumetric analysis. Calculations in volumetric analysis. Neutralization method. Preparation of primary and secondary standard solutions. Experimental control tasks: - Concentration of alkali in water solution; - Determination of temporary water hardness of water sample.	10
18	RedOx volumetric methods of quantitative analysis. Preparation of primary and secondary standard solutions of Permanganatometry and Iodometry. Experimental control tasks: - The permanganatometric determination of Fe(II) concentration in water solution of Mohr's salt; - The iodometric determination of Cu(II) content in solid copper vitriol.	4

1	2	3
19	Complexonometric volumetric method of quantitative analysis. Preparation of primary and secondary standard solutions of Trilonometry method. Experimental control tasks: - Determination of total water hardness of water sample; - Determination of Calcium content in water solution.	4
	Total	**60**

4. Topics for self-study

#	Chapter	Hours
1	Stoichiometric Laws. Application and limitation	2
2	Atomistic theory developing.	2
3	The foundations of condensed matter chemistry	2
4	Chemical reactions rate and chemical equilibrium in the environmental systems	2
5	Solutions and their concentrations	1
6	Intramolecular hydrolysis	1
7	Redox potentials. Standard electrode potentials of metals. Galvanic elements. The direction of redox reactions. Electrolysis as a redox process. Corrosion of metals as a redox process	2
8	Isomerism of complex compounds. The state of complex compounds in solution.	1
9	Special chemical properties and structure of water as medium of life origin. Features of the biological action and chemistry of selenium and its compounds	1
10	Inorganic chemistry of Arsenic subgroup	1
11	Silicon compounds in the biosphere. Borides and borates, polyborates. Aluminates and aluminosilicates.	1
12	Strontium and Barium as Calcium analogs; their role in living nature. Lithium, Rubidium and Cesium and their compounds in plant and animal metabolism	1
13	Biological functions of Copper(II), Zinc, Manganese. Toxic effects of Cadmium and Mercury and their compounds.	2
14	Types of analytical reactions and reagents, their characteristics; classification of analytical reagents and calculations of reaction sensitivity indicators.	2
15	Experimental techniques of qualitative inorganic analysis. Dry and wet reactions. Semimicro apparatus and semimicro analytical operations. Micro apparatus apparatus and microanalytical operations. Spot test analysis.	1
16	Training calculations of concentration units recalculations in the environmental application (heavy metals analysis, salty waters mineralization, etc)	1
17	The ionic strength of natural water systems (salty sea waters, blood, cell juice etc.). Osmosis and ionic strength. Calculation of common in effect and environmental problems (how to immobilize the heavy metals in soils etc.). Ionic strength calculator (https://www.omnicalculator.com/chemistry/ionic-strength)	2
18	pH graphic method determination. How to prepare of buffer solutions. TRIS solution – preparation and application. How to calculate titration curves of acid mixture titration. Choice of the best acid-base indicators and the interpretation	1
20	Assessment of reliability of analytical data. Reproducibility and correctness of experimental data. Types of systematic errors. Individual and instrumental systematic errors. Determination of systematic error and its influence on the results of the analysis. Random error. Basic concepts of classical statistics.	2
21	RedOx calculation of ionic species of metals of changing valencies in natural systems (iron, manganese). RedOx potential of natural waters and soils. Chemical	1

	oxygen demand (COD) of natural waters al application of RedOx volumetric methods in the environmental analysis.	
22	Chelates as food additives, drugs, and analytical reagents. Using of complexones in environmental sanitation.	1
	Total hours:	**30**

5. Tools for assessing expected learning outcomes:

- Exam;
- Module tests;
- On-line tests (via Elern platform);
- Abstracts;
- Presentation of laboratory works.

6. Teaching methods:

- Verbal method (lecture, discussion, interview);
- Practical method (laboratory classes);
- Visual method (demonstration method);
- Work with educational and methodical literature (summarizing, annotating, reviewing);
- Video method (multimedia, web-oriented);
- Independent work (task performance);
- Individual research work of students of higher education.

7. Assessment methods:

exam;
written assessment;
module tests;
essays and reports;
presentation of laboratory works.

8. Distribution of points received by students

The assessment of students' knowledge and skills is conducted by means of a 100-point scale and is converted into national grades according to Table 1 of the current *Exam and Credit Regulations at NULES of Ukraine*.

Student's rating, points	National grading of exams and credits	
	exams	credits
90-100	excellent	pass
74-89	good	
60-73	satisfactorily	
0-59	unsatisfactorily	fail

To determine a student's rating in the discipline $\mathbf{R_{DIS}}$ (up to 100 points), the received assessment rating $\mathbf{R_A}$ (up to 30 points) is added to the academic performance

raiting $\mathbf{R_{AP}}$ (up to 70 points): $\mathbf{R_{DIS}} = \mathbf{R_{AP}} + \mathbf{R_A}$.

9. Teaching and learning aids

- e-learning course of the discipline (*https://elearn.nubip.edu.ua/course/view.php?id=4107)*;
- lectures and presentations (in electronic form);
- textbooks, manuals, tutorials;
- guidelines for studying a discipline by full-time and part-time students.

10. Recommended sources of information

1.
2. Methodological guidelines “Inorganic and analytical chemistry for bachelor students’ specialty 201 – “Agronomy”. Voitenko L.V., Kopilevich V.A., Prokopchuk N.M. Savchenko D.A., Kravchenko O.O. Kyiv: Експо-Друк., 2022. 219 p.
3. Laboratory manual on Inorganic and Analytical Chemistry. Savchenko D.A., Voytenko L.V., Prokopchuk N.M. Kyiv: Експо-Друк., 2017. 216 p.
4. Неорганічна та аналітична хімія: підручник / В.А. Копілевич, Д.А. Савченко, Т.І.Ущапівська. К.: Редакційно-видавничий відділ НУБіП України. 2020. 596 с.
5. Неорганічна та аналітична хімія: навчальний посібник у формі лабораторного практикуму Д.А. Савченко, В.А. Копілевич, Т.І.Ущапівська, Н.М. Прокопчук. К.: ДДП «Експо-Друк». 2021. 329 с.
6. General and Inorganic Chemistry: textbook/V.O. Kalibabchuk, V.V. Ohurtsov, V.I. Halynska et al.; edited by V.O. Kalibabchuk. Kyiv : AUS Medicine Publishing, 2019. 456 p.