NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCE OF UKRAINE
DEPARTMENT OF ANALYTICAL AND BIOINORGANIC CHEMISTRY AND WATER QUALITY

“ ”**APPROVED**”
Dean of faculty of Plant
Protection, Biotechnology and Ecology

“_21___”_May_____2025.

CURRICULUM OF ACADEMIC DISCIPLINE

INORGANC AND ANALYTICAL CHEMISTRY

Field of knowledge H – Agriculture, forestry, fisheries and veterinary medicine
Specialty H 1 –Agronomy (Plant protection and Quarantine)
Education program Plant protection and Quarantine
Faculty of the Plant Protection, Biotechnology and Ecology
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Kyiv-2025

Description of the discipline INORGANIC AND ANALYTICAL CHEMISTRY

The natural sciences fall into two general categories – the biological sciences and the physical ones. The biological sciences are concerned primarily with the living things, and the physical sciences are concerned primarily with nonliving things, including rocks, the stars, electricity, the weather, energy from the sun, and the composition of all materials. Chemistry is a physical science.

In general, Chemistry is the study of the composition, structure, and the properties of substances and the changes they undergo. This definition may suggest to you that chemistry has little to do with everyday life. This is not true. Your way of life would be radically different without the practical applications of chemistry. Imagine a supermarket offering only fruits and vegetables grown without manufactured fertilizers and pesticides. The quantities and varieties offered would be far fewer. Imagine drinking water from your tap that had not been purified. The unpurified water would probably make you sick. Try to imagine a world without gasoline or heating oil. It would be very different from the world we live in. Chemistry is s very broad subject. Most chemists would describe themselves as working in one of the following major areas of the science:

Inorganic chemistry – the study of all substances not classified as organic chemicals, which includes the chemistry of all substances containing elements other than organic carbon; *Analytical chemistry* – the identification of substances and the qualitative and quantitative determination of the composition of materials.

Field of knowledge, direction, specialty, education and qualification level		
Educational and Qualification level qualification	bachelor	
Specialty	H 1 –Agronomy (Plant protection and Quarantine)	
Branch of knowledge	H – Agriculture, forestry, fisheries and veterinary medicine	
Characteristics of training programme		
Type	ordinary	
The total number of academic hours	_135_	
Number of ECTS credits allocated	4,5	
Number of modules	4	
Forms of control	Exam	
Indicators of academic discipline for full-time and part-time forms of training course		
	Full-time	**Part-time**
Year (course)	1	-
Semester	1	-
Number of lectures	30	-
Number of seminars, practical classes		-
Laboratory sessions (activities)	75	-
Independent study	30	-
Number of weekly in-class academic hours for full-time forms of training	7	-

Competencies of the educational program:

Integrative competency (IC):Ability to solve complex specialized problems and practical problems of professional activity with protection and quarantine of plants and apply theoretical knowledge and methods of phytosanitary monitoring, review, analysis, expertise, which are characterized complexity and uncertainty of conditions__

General competencies (GC):

- GC1. Ability to abstract thinking, analysis and synthesis
- GC2. Ability to apply knowledge in practical situations
- Professional (special) competencies (PC):

Program learning outcomes (ELO) of the educational programme:

- ELO 4 Have knowledge of the fundamental sections of higher mathematics, biophysics,
- chemistry (analytical, organic, inorganic, physical and colloid), botany and agrozoology to the extent necessary for understanding the processes of the specialty protection and plant quarantine.

2. **Program and structure of the discipline for full-time form of training**

Topics and modules to becovered	Number of hours											
	Full-time						Part-time					
	Total	including					Total	including				
		lect.	pract.	lab.	ind.	ind.		lect.	pract.	lab.	ind.	ind.
1	2	3	4	5	6	7	8	9	10	11	12	13
Module 1. **Theoretical foundations of inorganic chemistry**												
1. Introduction. General laws of stoichiometry and types of chemical reactions.	6	2		4		10						
2. Atomic structure of chemical elements.	4	2		2								
3. The Periodic Law and Periodic Table of chemical elements.	8	2		6								
4. Chemical bonding and structure of molecules.	6	2		4								
5. Chemical kinetics and equilibrium.	6	2		4								
Total with the module 1.	**40**	**10**		**20**		**10**						
Module 2.**Solutions, their nature and properties**												
1. Solutions, their nature and properties.	6	2		4		6						
2. Electrolytes and reactions in their solutions.	6	2		4								
3. Hydrolysis of salts.	8	1		6								
4. Coordination compounds.	6	1		5								
Total with the module 2.	**31**	**6**		**19**		**6**						
Module 3. **Redox reactions. Chemistry of elements**												
1.Redox reactions.	6	2		4		4						
2. Elements of VII-A sub- group.	4	2		2								
3.Elements of VI-A sub- group.	4	2		2								
4. Elements of V-A sub-group.	5	1		4								

5. General properties of metals.	5	1		4								
Total with the module3.	**28**	**8**		**16**		**4**						
Module 4. **Analytical Chemistry**												
1.Analytical chemistry as a science	4	2		2		10						
2. Qualitative analysis	10	2		8								
3.Quantitative analysis	12	2		10								
Total with the module 4.	**36**	**6**		**20**		**10**						
Totally	**135**	**30**		**75**		**30**						

3. Topic of Lectures

#	Name of topic	Number of hours
1	Introduction. General laws of stoichiometry and types of chemical reactions.	2
2	Atomic structure of chemical elements.	2
3	The Periodic Law and Periodic Table of chemical elements.	2
4	Chemical bonding and structure of molecules.	2
5	Chemical kinetics and equilibrium.	2
6	Solutions, their nature and properties.	2
7	Electrolytes and reactions in their solutions.	2
8	Hydrolysis of salts.	1
9	Coordination compounds.	1
10	Red-ox reactions.	2
11	Elements of VII-A sub- group.	2
12	Elements of VI-A sub- group.	2
13	Elements of V-A sub-group.	1
14	General properties of metals.	1
15	Analytical chemistry as a science	2
16	Qualitative analysis	2
17	Quantitative analysis	2
	Totally	**30**

4. Topic of laboratory classes

#	Name of topic	Number of hours
1	General rules of activity in chemical laboratory. Rules of laboratory research. Control test – level of the secondary school knowledge.	4
2	Principles of classification of inorganic compounds and these ranges.	4
3	Studying of the chemical properties of different types of inorganic	4

	compounds. Control test – classification and properties of inorganic compounds.	
4	Rules of composition of electronic formulas of the chemical elements, determination of their possible valence and oxidation numbers.	4
5	Types of chemical bonding and structure of molecules of acids, bases, salts, oxides. Control test – compilation of electronic formulas and determination of types of chemical bonding.	4
6	Solutions, their nature and properties. Units of concentration.	4
7	The rules of the chemical reactions compilation in the solutions of electrolytes. Control test: ionic reactions.	4
8	The rules of the chemical reactions compilation of the salts hydrolysis and determination of pH. Lecture's control test: hydrolysis of salts.	4
9	Rules of compilation of red-ox reactions. Control test.	4
10	Rules of compilation of coordinative compounds formulas and reactions with their participation. Studying of their properties. Control test.	4
11	Halogens and their compounds on the example of chlorine and bromine.	4
12	Oxygen, sulfur and their compounds.	4
13	Nitrogen, phosphorus and their compounds. Control Test.	4
14	Chemical properties of the same metals of main and secondary sub-groups. Control Test. The first analytical group of cations	4
15	The second analytical group of cations. The third analytical group of cations	7
16	The forth analytical group of cations. The first analytical group of anions. The second analytical group of anions.	4
17	The third analytical group of anions. Analysis of unknown substances	4
18	Determination of alkali solution normality. Complexometric titration Permanganatometric determination of Iron(II) content in Mohr's salt.	4
	Totally	**75**

5. Topic for self-study

#	Name of topic	Number of hours
1	Molar ratios molar masses, balancing and interpreting equations, conversions between grams and moles. The electronic arrangements and dots and crosses diagrams. Atomic number as the basis for the Periodic Law. Long form periodic table.	8
2	Lewis Structures. Exceptions to Regular Lewis Structures - resonance structures. Catalysts and catalysis. Dynamic equilibria. Colligative properties of solution.	8
3	Dilute concentrations units: ppm, ppb,ppt. Use of Hydrolysis in the "Real World". Lewis Acid-Lewis base approach to bonding in complexes. Half-reactions. Nernst Equation.	6

4	Metal halides. Interhalogen compounds. Allotropes of Oxygen and Sulfur. Occurrence of pnictogens. Properties of alkali and alkali-earth	8
	Totally	**30**

6. **Tools for assessing expected learn outcomes:**

- Exam;
- Module test;
- Referates;
- Laboratory works;
- Abstracts.
- Presentation of laboratory works.

Teaching Methods

- Verbal methods (lecture, interview)
-Practical methods (Laboratory works)
- Visual methods (demonstration methods)
- Independent work (task performance)

7. Assessment methods

Forms of control:
-exam
-test
-control work
-module test
-laboratory work.

8. Distribution of points received by students

Distribution of points received by students. The student's knowledge is assessed on a 100-point scale and translated into national assessments according to the table. 1 "Regulations on examinations and assessments at NUBiP of Ukraine" (order on implementation dated 26.04.2023, protocol No. 10)

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.

8.1. Distribution of points by types of educational activities

Type of educational activity	Learning outcomes	Evaluation
Module 1. **Theoretical foundations of inorganic chemistry**		
Lecture 1. Introduction. General laws of stoichiometry and types of chemical reactions.		**-**
Laboratory class 1. General rules of activity in chemical laboratory. Rules of laboratory research. Control test – level of the secondary school knowledge.	Ability and used to abstract thinking, analysis and synthesis	**10**
Lecture 2. Atomic structure of chemical elements.		**-**
Laboratory class 2. Principles of classification of inorganic compounds and these ranges.	Ability and used to abstract thinking, analysis	**10**
Lecture 3. The Periodic Law and Periodic Table of chemical elements.		**-**
Laboratory class 3. Studying of the chemical properties of different types of inorganic compounds.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory.	**10**
Lecture 4. Chemical bonding and structure of molecules.		**-**
Laboratory class 4. Rules of composition of electronic formulas of the chemical elements, determination of their possible valence and oxidation numbers.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory.	**10**
Lecture 5. Chemical kinetics and equilibrium.		**-**
Laboratory class 5. Types of chemical bonding and structure of molecules of acids, bases, salts, oxides.	Ability and used to abstract thinking, analysis	**10**
Self-study work 1**.** Molar ratios molar masses, balancing and interpreting equations, conversions between grams and moles. The electronic	Ability to learn and master today and modern knowledge on topic Theoretical	**20**

arrangements and dots and crosses diagrams. Atomic number as the basis for the Periodic Law. Long form periodic table.	foundations of inorganic chemistry. Basic	
Module control 1.	Ability to learn and master today and modern knowledge on topic Theoretical foundations of inorganic chemistry. Basic laws of chemical transfor-mations	**30**
∑ **Module 1**		**100**
Module 2. **Solutions, their nature and properties**		
Lecture 6. Solutions, their nature and properties.		**-**
Laboratory class 6. Solutions, their nature and properties. Units of concentration.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Lecture 7. Electrolytes and reactions in their solutions.		**-**
Laboratory class 7. The rules of the chemical reactions compilation in the solutions of electrolytes.		**10**
Lecture 8. Hydrolysis of salts.		**-**
Laboratory class 8. The rules of the chemical reactions compilation of the salts hydrolysis and determination of pH.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Lecture 9. Coordination compounds.		**-**
Laboratory class 9. Rules of compilation of red-ox reactions.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Self-study work 2**.** Lewis Structures. Exceptions to	Ability to learn and master today and	**30**

Regular Lewis Structures - resonance structures. Catalysts and catalysis. Dynamic equilibria. Colligative properties of solution.	modern knowledge on topic Solutions, their nature.	
Module control 2.	Ability to learn and master today and modern knowledge on topic Solutions, their nature and properties	**30**
∑ **Module 2**		**100**
Module 3. **Redox reactions. Chemistry of elements**		
Lecture 10. Red-ox reactions.		**-**
Laboratory class 10. Rules of compilation of coordinative compounds formulas and reactions with their participation. Studying of their properties.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Lecture 11. Elements of VII-A sub- group		**-**
Laboratory class 11. Halogens and their compounds on the example of chlorine and bromine.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Lecture 12. Elements of VI-A sub- group		**-**
Laboratory class 12. Oxygen, sulfur and their compounds.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Lecture 13. Elements of V-A sub-group.		**-**
Laboratory class 13. Nitrogen, phosphorus and their compounds.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**

Lecture 14. General properties of metals.		**-**
Laboratory class 14. Chemical properties of the same metals of main and secondary sub-groups	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Self-study work 3. Dilute concentrations units: ppm, ppb, ppt. Use of Hydrolysis in the "Real World". Lewis Acid-Lewis base approach to bonding in complexes. Half-reactions. Nernst Equation	Ability to learn and master today and modern knowledge on Redox reactions. Chemistry of elements.	**20**
Module control 3.	Ability to learn and master today and modern knowledge on Redox reactions. Chemistry of elements.	**30**
∑ **Module 3**		**100**
Module 4. **Analytical Chemistry**		
Lecture 15. Analytical chemistry as a science		**-**
Laboratory class 15. The first analytical group of cations. The second analytical group of cations. The third analytical group of cations	Ability and used to abstract thinking, analysis and synthesis	**20**
Lecture 16. Qualitative analysis.		**-**
Laboratory class 16. The forth analytical group of cations. The first analytical group of anions. The second analytical group of anions.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**20**
Lecture 17. Qualitative analysis		**-**
Laboratory class 17. The third analytical group of anions. Analysis of unknown substances	Ability and used to abstract thinking, analysis and synthesis	**20**

Laboratory class 18. Determination of alkali solution normality. Complexometric titration Permanganatometric determination of Iron(II) content in Mohr's salt.		**10**
Self-study work 4. Metal halides. Interhalogen compounds. Allotropes of Oxygen and Sulfur. Occurrence of pnictogens. Properties of alkali and alkali-earth.	Ability to learn and master today and modern knowledge on Theoretical and experimental foundations of quantitative	**20**
Module control 4.	Ability to learn and master today and modern knowledge on Theoretical and experimental foundations of quantitative chemical analysis.	**30**
∑ Module 4		**100**
Study work		**(M1 + M2 +M3 + M4)/4*0,7 ≤ 70**
Exam		**30**
Course		**(Study work +exam) ≤ 100**

8.2. Higher education student knowledge assessment scale

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 $\mathbf{R_{DIS}}$ (upto100points), the received assessment rating $\mathbf{R_A}$ (upto30points) is added to the academic performance raiting $\mathbf{R_{AP}}$ (up to 70 points): $\mathbf{R_{DIS}} = \mathbf{R_{AP}} + \mathbf{R_A}$.

8.3. Evaluation Policy

Deadline and resubmission policy	EXAMPLE: Works submitted after the deadline without a valid reason will be graded lower. Modules can be re-assigned with the permission of the lecturer if there is a valid reason (e.g. sick leave).
Academic Integrity Policy	EXAMPLE: Cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct text references to the literature used
Visitation Policy	EXAMPLE: Attendance at classes is mandatory. For objective reasons (e.g. illness, international internship), studies may be conducted individually (online upon agreement with the dean of the faculty).

9. Technology and methodological requirements

1. Voytenko L., Kopilevich V., Prokopchuk. Inorganic Chemistry. Manual. N. - Kyiv: NUBiP of Ukraine., 2020. - 148 p.
2. Voytenko L., Kopilevich V., Prokopchuk N. Workbook on Inorganic Chemistry. - Kyiv: NUBiP of Ukraine, 2019. - 85 p.
3. Voytenko L., Kopilevich V., Prokopchuk N. Laboratory manual on general and inorganic chemistry for bachelors students specialty 162 – "Biotechnology and bioeingeneering - Kyiv: NUBiP of Ukraine., 2024. - 203 p.
4. Lavrik R.V. Inorganic and analytical chemistry URL:https://elearn.nubip.edu.ua/course/view.php?id=1185

10. Recommended sources of information

1. Morris Hein, Leo R. Best, Scott Pattison and Susan Arena.Introduction in General, Organic and Biochemistry, 7th Edition, by Brooks/Cole Publishing Co., 2020, 872 pp.
2. D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman. Inorganic and analytical Chemistry, second edition. NewYork, 2023, 913 pp.
3. https://elearn.nubip.edu.ua/course/view.php?id=1185
4. Diclofenac and Omeprazole Electrochemical Determination on Cobalt (III) Oxyhydroxide-Modified Electrode. A Theoretical Study 2024 Letters in Applied Nano-BioScience, Q4, Vol. №13, Issue 2.p.98 -103. Volodymyr V. Tkach, Marta V. Kushnir, Ruslan V. Lavrik https://doi.org/10.33263/LIANBS132.098
5. The Theoretical Description for Electrochemical Hydroxyquinol and Phloroglucinol Electrochemical Detection Over CoO(OH)-Modified

Electrode, 2024, Letters in Applied Nano-BioScience, Q4 Vol. №13, Issue 3.p.133-136. Volodymyr V. Tkach, Marta V. Kushnir, Ruslan V.Lavriik https://doi.org/10.33263/LIANBS133.136

6. Theoretical Description for Lugduname and Perillartin Electrochemical Determination by Cathodic Route 2024, Letters in Applied Nano-BioScience, Q4 Vol. №13, Issue 4.p.162 -167. Volodymyr V. Tkach, Tetiana V. Morozova, Ruslan V. Lavrik, https://doi.org/10.33263/LIANBS134.162