NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Analytical and Bioinorganic Chemistry and Water quality

APPROVED Agrobiological faculty

<u>"10" June</u> 2025

CURRICULUM OF ACADEMIC DISCIPLINE INORGANIC AND ANALYTICAL CHEMISTRY

Area of knowledge H - <u>Agriculture, forestry, fisheries and veterinary medicine</u> Specialty <u>H1 – Agronomy</u> Academic program <u>Agronomy</u> Faculty (Institute) <u>Agrobiological</u> Developed by: <u>Assoc. prof, PhD in Chemistry, associated professor of Department</u> of Analytical and Bioinorganic Chemistry and Water Quality Prokopchuk N.M., <u>Assoc. prof, PhD in Biology, associated professor of Department of Analytical and</u> <u>Bioinorganic Chemistry and Water Quality Kravchenko O.O</u>

Description of the discipline Inorganic and Analytical Chemistry

The discipline "Inorganic and Analytical Chemistry" belongs to the basic general education subjects and ensures the formation of the foundation of knowledge and skills of a specialist in the agronomic field, necessary for studying professionally oriented and special disciplines. Studying the course of the discipline is aimed at mastering knowledge about chemical laws and regularities of chemical transformations with an orientation to the processes occurring in the environment and the formation of the theoretical and practical level of students, the skills of performing a chemical experiment, necessary for mastering special subjects that use chemical analysis of natural and artificial objects. The student must be able to: use educational, methodical and reference literature on inorganic and analytical chemistry (including in elearn), carry out calculations based on the equations of chemical reactions and processes, solve calculation problems using computer technology, perform chemical reactions independently in practice, conduct laboratory research.

Area of knowledge, specialty, academic programme, academic degree				
Academic degree	Bachelor			
Specialty	H1 - Agronomy			
Academic program	Agronomy			
Characte	eristics of the course			
Туре	oblig	gatory		
Total number of hours	1	50		
Number of ECTS credits		5		
Number of modules		4		
Course project (work) (if any)		-		
Form of assessment	exam			
Indicate	ors of the discipline			
for full-time and par	t-time forms of univer	sity study		
	Full-time	Part-time		
Year of study	1			
Term	1			
Lectures	30			
Practical classes and seminars	-			
Laboratory classes	75			
Self-study	45			
Number of hours per week for	7			
full-time students				

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

Aim is to build a good foundation in chemical knowledge that allows to make qualitative and quantitative inquiries into topics in natural science.

Competences acquired:

Integral competence (IC):

The ability to solve complex specialized tasks and practical problems in agronomy, which involves the application of theories and methods of the relevant science and is characterized by complexity and compliance with zonal conditions.

General competences (GC):

GC 7. Ability to apply knowledge in practical situations;

GC 8. Skills of performing safe activities;

GC 9. Ability to search, process and analyze information from various sources; GC 11. Efforts to preserve the environment.

Special (professional) competence (SC):

SC7. The ability to scientifically use fertilizers and plant protection products, considering their chemical and physical properties and impact on the environment.

Expected learning outcomes (ELO):

ELO 4. To compare and evaluate modern scientific and technical achievements in the field of agronomy;

ELO 6. Demonstrate knowledge and understanding of fundamental disciplines to the extent necessary for mastery of relevant skills in the field of agronomy;

ELO 10. Analyze and integrate knowledge from general and special professional training to the extent necessary for specialized professional work in the field of agronomy;

	Number of hours												
			Fu	ll tir	ne					Pa	rt tim	e	
Modules and topics	Week	То			inclu	ding		То			inclu	ling	
	s	tal	1	р	la	in	St.s	tal	1	р	la	in	St.s
					b	d					b	d	
1	2	3	4	5	6	7	8	9	1	1	12	13	14
									0	1			
Module №1. Theoreti	cal found	latior	is of in	lorg	anic	chem	istry. Th	e Mai	in La	ws o	f che	mical	
			trans	sfor	matic	ns			r —	1			
Topic #1. Introduction.	1	12	2	-	6	-	4						
General notions,													
stoichiometrical laws and													
types of chemical reactions													
Topic #2. Atomic structure	1	12	2	-	4	-	4						
of chemical													
elements. Electronic formul													
as		-											
Topic #3. The Periodic Law	1	6	2	-	-	-	4						
and Periodic Table of													
chemical elements	1	10	2				2						
Topic #4. Chemical	1	12	2	-	4	-	3						
bonding and structure													
of molecule. Chemical													
kinetics and equilibrium	10.1		0		1.4		1.						
I otal hours (module 1)	42 hours 8 - 14 - 15												
Module №2. Chemical t	ransforn	natio	ns with	ı ch	ange	of ox	idation r	umbe	er of	elem	ents	or the	ir
				vale	nce								

2. Programme and structure of the discipline:

Topic #5. Solutions, their	1	12	2	-	6	-	2						
nature and properties.													
Hydrolysis of salts													
Topic #6. Red-Ox reactions	1	16	2	-	8	-	2						
Topic #7. General	1	8	2	-	2	-	2						
properties of non-metals													
Topic #8. General	1	8	2	-	2	-	2						
properties of metals													
Topic #9. Coordination	1	10	2	-	6	-	2						
compounds													
Total hours (module 2)	54 hour	rs	10	-	24	-	10						
Module No3. Princ	iples and	metl	nods of	fQı	ıalita	tive A	Analysis o	of Cat	tions	and	Anio	ns	
Topic #10. Introduction to	1	28	2	-	15	-	6						
Analytical chemistry													
Topic #11-12. Qualitative	2	20	4	-	8	-	4						
analysis. The main													
principle of qualitative													
analysis of unknown													
substances													
Total hours (module 3)	48 hou	rs	6	-	23	-	10						
Module №4. Theoretic	cal and e	xperi	menta	l foi	unda	tions	of Quant	itativ	e che	emica	al ana	alysis.	
Gravimetry and no	eutraliza	tion r	nethoo	I. R	ed O	x met	hods and	l com	plexi	ng m	netho	ds.	
Topic #13. Theoretical and	1	12	2	-	6	-	2						
experimental foundanion of													
Quntitative analysis													
Topic #14. Titrimetry	1	12	2	-	4	-	3						
(volumetry, volumetric													
analysis). Neutralization													
method													
Topic #15. Oxidation-	1	12	2		4		3						
reduction (Redox) Titration													
(Redoxmetry).													
Complexometric Titration													
			-										
Total hours (module 4)	36 ho	urs	6	-	14	-	10						

3. Topics of lectures

N⁰	№ Topic title	
1	Introduction. General notions, stoichiometrical laws and types of	2
	chemical reactions.	
2	Atomic structure of chemical elements. Electronic formulas.	2
3	The Periodic Law and Periodic Table of chemical elements	2
4	Chemical bonding and structure of molecule. Chemical kinetics and	2
	equilibrium	
5	Solutions, their nature and properties. Hydrolysis of salts	2
6	Red-Ox reactions	2
7	General properties of non-metals	2
8	General properties of metals	2
9	Coordination compounds	2
10	Introduction to Analytical chemistry	2
11	Qualitative analysis.	2
12	The main principle of qualitative analysis of unknown substances	2

Total h	ours	30
	Titration	
15	Oxidation-reduction (Redox) Titration (Redoxmetry). Complexometric	2
14	Titrimetry (volumetry, volumetric analysis). Neutralization method	2
13	Theoretical and experimental foundation of Quntitative analysis	2

4. Topic of laboratory (practical, seminars) classes

№	Topic title	Hours
	Inorganic chemistry	
Mo	dule No1. Theoretical foundations of inorganic chemistry. The Main	Laws of
	chemical transformations	
1.1	The main classes of inorganic substances	4
1.2	Control Test "Classification of Inorganic Substances"	2
1.3	Atomic structure. Chemical bonding	2
1.4	Control Test "Atomic Structure. Electron configurations of atoms.	2
	Chemical bonding"	
1.5	Theory of electrolytic dissociation	2
1.6	Control Test "Theory of electrolytic dissociation"	2
Ν	Aodule №2. Chemical transformations with change of oxidation num	iber of
	elements or their valence	
2.1	Ionic product of water. Hydrolysis of salts	4
2.2	Control Test "Hydrolysis of Salts"	2
2.3	Oxidation-reduction reactions	8
2.4	Control Test "RedOx reactions with products"	2
2.5	Control Test "RedOx reactions without products"	2
2.6	Complex (coordination) compounds	4
2.7	Control test "Complex (coordination) compounds"	2
	Total hours from the section "Inorganic chemistry": 38 hours.	
	Analytical chemistry	
N	Iodule No3. Principles and methods of Qualitative Analysis of Cations and	Anions
2.1	The first group of Cotions	2
3.1.		Δ
3.2	The second group of Cations	5
3.3	The third group of Cations	4
3.4	The fourth group of Cations	2
3.5	The first group of Anions	2
3.6	The second group of anions	2
3.7	The third group of Anions.	2
3.8	Control Test "Analysis of Unknown substance"	4
Modu	ule No4. Theoretical and experimental foundations of Quantitative chemica	al analysis.
Grav	imetry and neutralization method. Red Ox methods and complexing methods	nods
4.1	Preparation of solution	4
4.2	Control test "Concentration of Solutions"	2
4.3	Determination of alkali solution normality	4
4.4	Determination of Water Hardness	4
Total	hours from the section "Analytical chemistry": 37 hours.	
	Total lab hours:	75
		hours.

5. Topics of self-study

N⁰	Topic title	Total hours
1	Basic concepts of chemistry. Classification of inorganic substances	15
2	Chemical transformations metals and non-metals	10
3	Analysis of unknown substances	10
4	Solutions. Methods of expressing the concentration of solutions	10
Total h	ours	45

6. Methods of assessing expected learning outcomes:

- oral or written survey;
- interview;
- test;
- defending laboratory works, projects;

7. Teaching methods:

- problem-based method;
- practice oriented studying method;
- case method;
- project education method;
- flipped classroom, mixed education method;
- research based method;
- learning discussions and debates method;
- team work, brainstorm method.

8. Results assessment.

The student's knowledge is assessed by means of a 100-point scale converted into the national grades according to the "Exam and Credit Regulations at NULES of Ukraine" in force.

Educational activity	Results	Assessment
Module №1. Theoretical f	oundations of inorganic chemistry. The I	Main Laws of
	chemical transformations	
Lab. 1.1. The main classes	ELO 4, ELO 6, ELO 10:	5
of inorganic substances	Understand and apply the basic concepts	
Lab. 1.2. Control Test	of stoichiometry and types of chemical	25
"Classification of	reactions in the context of agronomic	
Inorganic Substances"	processes. (ELO 6, ELO 10)	
Lab. 1.3. Atomic structure.	Analyze the atomic structure and	8
Chemical bonding	formulate electronic configurations of	
Lab. 1.4. Control Test	elements relevant to plant nutrition and	12
"Atomic Structure.	soil chemistry. (ELO 6, ELO 10)	

8.1. Distribution of points by types of educational activities

Electron configurations of	Evaluate the significance of the Periodic	
atoms. Chemical bonding"	Law and Periodic Table for predicting	
Lab 1.5 Theory of	the properties of elements in fertilizers	5
electrolytic dissociation	and agrochemicals. (ELO 4, ELO 6)	5
Lab. 1.6. Control Test	Explain the chemical bonding and	18
"Theory of electrolytic	molecular structure types, and apply	
dissociation"	chemical kinetics and equilibrium to	
Independent Study for	agronomic systems such as soil-buffer	12
Module #1.	interactions. (ELO 6, ELO 10)	
Control Test for Module		15
#1.		
Totally for Module #1.		100
Module №2. Chemical t	ransformations with change of oxidation	number of
	elements or their valence	
Lab. 2.1. Ionic product of	ELO 4, ELO 6, ELO 10:	5
water. Hydrolysis of salts	Interpret the physical and chemical	
Lab. 2.2. Control Test	properties of solutions, including salt	20
"Hydrolysis of Salts"	hydrolysis, in relation to soil pH and	
Lab. 2.3. Oxidation-	nutrient availability. (ELO 6, ELO 10)	5
reduction reactions	Identify and balance RedOx reactions	
Lab. 2.4. Control Test "	and apply this understanding to RedOx	10
reactions with products"	processes in soil and plant metabolism.	
Lab. 2.5. Control Test	(ELO 6, ELO 10)	20
"RedOx reactions without	Analyze the chemical behavior of metals	
products"	and non-metals as components of	
Lab. 2.6. Complex	agroecosystems (e.g., micronutrients,	5
(coordination) compounds	toxicity, remediation). (ELO 4, ELO 10)	
Lab. 2.7. Control test	Evaluate the structure and role of	10
"Complex (coordination)	agrochemical formulations and	
compounds"	micronutrient complexes such as	
Independent Study for	chelates (ELO 4 ELO 6 ELO 10)	5
Module #2.		20
Control Test for Module #2		20
Totally for Module #2		100
Modulo No2 Principles	and mothods of Qualitative Analysis of (Totions and
Module Mgs. I Thicipies	Anions	Lations and
Lab 3.1 The first group	FLO4 FLO6 FLO10	5
of Cations	Demonstrate understanding of analytical	5
Lab. 3.2. The second	chemistry principles and their role in	10
group of Cations	detecting and identifying cations/anions	10
Lab. 3.3. The third group of	in modern agronomic analysis (ELO 6,	5
Cations	ELO 10)	-
Lab. 3.4. The fourth group	Apply qualitative analysis methods to	5
of Cations	identify macro- and micronutrient	
Lab. 3.5. The first group	content in agricultural samples. (ELO 6,	5
of Anions	ELO 10)	
Lab. 3.6. The second group	Integrate qualitative analytical results to	5
of anions	assess agroecosystems' status and	
Lab. 3.7. The third group of		5
Anions.		

Lab. 3.8. Control Test "Analysis of Unknown	support agronomy decision-making. (ELO 4, ELO 10)	20
substance"		
Independent Study for		20
Module #3.		
Control Test for		20
Module #3.		
Totally for Module #3.		100
Module №4. Theoretical a	nd experimental foundations of Quantita	tive chemical
analysis. Gravimetry	and neutralization method. Red Ox met	hods and
	complexing methods	
Lab. 4.1. Preparation of	ELO 4, ELO 6, ELO 10:	10
solution	Understand and apply gravimetric and	
Lab. 4.2. Control test	volumetric methods for quantitative	40
"Concentration of	chemical analysis of substances relevant	
Solutions"	to plant and soil chemistry. (ELO 6,	
Lab. 4.3. Determination of	ELO 10)	10
alkali solution normality	Perform and use neutralization, RedOx	
Lab. 4.4. Determination of	and complexometric titrations to	10
Water Hardness	evaluate the concentration of elements	
Independent Study for	(e.g., Fe, Mn, Ca, Mg) in agronomic	10
Module #4.	samples. (ELO 4, ELO 6, ELO 10)	
Control Test for		20
Module #4.		
Totaly for Module #4.		100
Class work	$(M_1+M_2+M_3+M_4)/4*0.7 \le 70$)
Exam/credit	30	
Total for year	(Class work + exam) ≤ 100	

8.2. Scale for assessing student's knowledge

Student's rating, points	National grading (exam/credits)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

8.3. Assessment policy

Deadlines and exam retaking rules	Assignments submitted after the deadline
0	without a valid reason will receive a reduced
	grade. Retaking modules is allowed only with
	the lecturer's permission and upon presentation
	of a valid reason (e.g., a medical certificate).
Academic integrity rules	Cheating during tests or examinations is strictly
O V	prohibited, including the use of mobile devices
	or other unauthorized aids.

Attendance rules	Class attendance is mandatory. In cases of
	justified absence (e.g., illness, international
	internship), students may continue their studies
	individually online (approved by the Dean of
	the Faculty).

9. Teaching and learning aids

- 1. electronic educational course of the educational discipline (on the educational portal of NUBiP of Ukraine eLearn <u>https://elearn.nubip.edu.ua/course/view.php?id=2471</u>);
- 2. Inorganic and Analytical Chemistry: Manual [for students specialty 201 Agronomy»]/Savchenko D.A., Kopilevich V.A., Uschapivska T.I., Prokopchuk N.M. – Kyiv: NULES Publ., 2023. – 328 p. (In Ukrainian).
- Inorganic and Analytical Chemistry: Tutorial: [for students of higher educational institutions III-IV accreditation level, specialty 201 Agronomy»] / Savchenko D.A., Voitenko L.V., Prokopchuk N.M. – Kyiv: NULES Publ., 2018. – 480 p.
- 4. Guidelines for laboratory practice and independent work INORGANIC AND ANALYTICAL CHEMISTRY PART # 1 INORGANIC CHEMISTRY For bachelor students Specialty 201 – "Agronomy"/Voitenko L.V., Kopilevich V.A., Prokopchuk N.M., Kravchenko O.O., Savchenko D.A. – Kyiv: Експо-Друк., 2024. - 162 p.
- 5. Guidelines for laboratory practice and independent work INORGANIC AND ANALYTICAL CHEMISTRY PART # 2 ANALYTICAL CHEMISTRY For bachelor students Specialty 201 – "Agronomy"/Voitenko L.V., Kopilevich V.A., Prokopchuk N.M., Kravchenko O.O., Savchenko D.A. – Kyiv: Експо-Друк., 2024. - 160 p.

10. Recommended sources of information

1. 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, 2020. — 456 p.

2. Quantitative Chemical Analysis (10th Edition)/ Daniel C. Harris – Macmillan Learning, 2020. – 825 p.

3. Inorganic Chemistry (4th Edition)/ James E. House, Canada, 2025. – 950 p.

4. Toward the Development of the Ukrainian Water Quality Index Larysa V.. Voitenko, Tatiana I. Ushchapivska, Olha O.. Kravchenko, Nadiia M.. Prokopchuk, Leonid M.. Abarbarchuk 1056-SEMIT2025

5. Hnatiuk, T., Kravchenko, O., Abarbarchuk, L., Churilov, A., & Chobotar, V. (2023). Influence of drugs produced by electropulse ablation methods on the development of soybean phytopathogenic bacteria. Plant and Soil Science, 14(3), 22-34. https://doi.org/10.31548/plant3.2023.22

6. Antraptseva N.M., Solod N.V., Kravchenko O.O. Crystallization features of solid solutions of hydrated diphosphates in the system $ZnSO_4$ – $CoSO_4$ – $K_4P_2O_7$ – H_2O . Funct. Mater. 2024; 31 (3): 396-404. https://doi.org/10.15407/fm31.03.396

7. Chobotar, V.V., Kopilevich, V.A., Kravchenko, O.O. Analysis of Natural Water Quality in the Dniester River Basin for Economic Utilization. *J. Water Chem. Technol.* **46**, 636–644 (2024). <u>https://doi.org/10.3103/S1063455X24060031</u>

8. Antraptseva, N. M., Kochkodan, O. D., Solod, N. V., & Kravchenko, O. O. (2023). The behavior of $Co_{3x}M^{\mu}(PO_4)_2$ -8H₂O (M¹¹ = Mg, Mn, Zn) solid solutions at elevated temperatures. *Functional materials*, *30*(4), 519-525. https://doi.org/10.15407/fm30.04.519