NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of General, Organic and Physical Chemistry

"CONFIRMED"
Dean of the faculty
of Design and Engineering
Zinoviy RUZHYLO
2024.

"APPROVED"
at the meeting of the department of
General, Organic and Physical chemistry
Protocol № 11 from 08. 05. 2024
Head of the Department
Andrii HALSTYAN

"REVIEWED"
Guarantor of OP "Construction and Civil Engineering"
Yevhen DMYTRENKO

CURRICULUM OF ACADEMIC DISCIPLINE "CHEMISTRY"

Field of knowledge 19 "Architecture and construction"
Speciality 192 Construction and Civil Engineering
Educational program Construction and Civil Engineering
Faculty Design and Engineering

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Kyiv – 2024

1. Description of the course

CHEMISTRY

Field of knowledge, direction, specialty, education and qualification level		
Educational degree	*Bachelor*	
Specialization	*192 – Construction and Civil Engineering*	
Educational program	*Construction and Civil Engineering*	
Characteristics of the course		
Type	Compulsory	
Total number of hours	120	
Number of ECTS credits	4	
Number of content modules	3	
Form of assessment	Exam	
Indicators of academic discipline for full-time and part-time forms of training course		
	Full-time	**Part-time**
Course (year of study)	2024	2024
Semester	1	1
Lecture classes	15 hours	6
Laboratory classes	30 hours	4
Self-study	75 hours	110
Individual assignments		
Number of weekly classroom hours for the full-time form of study	3 hours 5 hours	

2. Purpose, objectives, and competencies of the course

Purpose. Students explore the fundamental chemical principles and their applications to the properties and transformations of materials. The course provides an overview of the field of electrochemistry with a focus on the chemical aspects of the interfacial processes.

The main goals of the course are – to provide a solid foundation in the study of matter and its changes and to understand and apply basic chemistry concepts in branch engineering.

Learning outcomes of course is the student's ability as a future specialist:

- outlines the historical development of major principles, concepts and ideas in chemistry;
- describes applications of chemistry which affect society or the environment;
- explains trends and relationships between elements in terms of atomic structure, the periodic table and bonding;
- describes chemical changes in terms of energy inputs and outputs;
- compiles the different chemical reaction, describes factors that influence the type and rate of chemical reactions;
- relates the uses of carbon to the unique nature of carbon chemistry;
- applies simple electrochemical processes;

Acquisition of competencies:

Integrated competency (IC): The ability to solve complex specialized construction and civil engineering tasks in the learning process, which involves the application of a set of theories and methods for determining strength, stability, deformability, modeling, strengthening of building structures; further safe operation, reconstruction, construction and installation of buildings and engineering structures; application of automated design systems in the field of construction.

General competencies (GC):

GC 1 – Ability to abstract thinking, analysis and synthesis.
GC 2 – Knowledge and understanding of the subject area and professional activity.
GC 6 – Ability to search, process and analyze information from various sources sources
GC 7 – Interpersonal skills.

Professional (special) competences (PC):

PC1 – Ability to use conceptual scientific and practical knowledge of mathematics, chemistry and physics to solve complex problems practical problems in the field of construction and civil engineering.

Program learning outcomes (PLO):

PLO 1 – Apply basic theories, methods and principles mathematical, natural, socio-humanitarian and economic sciences, modern models, methods and software tools to support adoption solutions for solving complex construction and civil engineering problems engineering.

3. Program and structure of the course

Structure of the course "Chemistry"

Names of content modules and topics	Number of hours												
	Full time form							Part-time form					
	week	total	included					total	including				
			l	p	lab	ind	self		l	p	lab	ind	self
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Content Module 1. **The basics atomic-molecular theory of the matter structure**													
Topic 1. The main concepts and laws of chemistry	1	10	1		2		7	9					9
Topic 2. Atomic structure	1	11	1		2		8	10,5	1		0,5		9
Topic 3. The periodic law and Mendeleev's periodic table of chemical elements	3	8	1		0		7	9					9
Topic 4. The chemical bond and the structure of molecules	3	11	1		2		8	11,5	1		0,5		10
Total for content module 1	40		4		6		30	40	2		1		37
Content Module 2. **Basic patterns of chemical processe**													
Topic 1. Thermodynamic laws of chemical transformations. Kinetics of chemical reactions	5	8	1		2		5	7					7
Topic 2. Properties of solutions of electrolytes and non-electrolytes. Electrolytic dissociation	5	10	1		4		5	8,5	1		0,5		7
Topic 3. The redox processes and their conditions	7	8	2		2		4	8,5	1		0,5		7
Topic 4. Fundamentals of electrochemistry. Chemical current sources	9	7	1		2		4	8	0,5		0,5		7
Topic 5. Electrolysis of melts and solutions of	9	7	1		2		4	8	0,5		0,5		7

electrolytes as oxidation - reduction process													
Total for content module 2	40		6		12		22	40	3		2		35
Content Module 3. **Chemistry of elements and compounds of elements that make up the basis of inorganic and organic building materials**													
Topic 1. Properties of metals and their compounds in building materials.	11		1		4		6	6,5					9
Topic 2. Corrosion processes and materials protection against corrosion	11		1		4		6	7	0,5		0,5		10
Topic 3. Bases of organic chemical compounds.	13		2		2		5	8	0,5				9
Topic 4. Polymeric materials and their applications in engineering	15		1		2		6	8			0,5		10
Total for content module 3	40		5		12		23	40	1		1		38
Total hours	120		15		30		75	120	6		4		110
Course project (work) with			-	-	-		-						
Total hours	120		15		30		75	120	6		4		110

6. Laboratory class topics

№	Topic	Hours
1.	Introduction. Equipment and safety in chemical laboratory. Methods of chemical experiments.	2
2.	Bases of modern nomenclature and classification of inorganic compounds.	2(0,5)
3.	The structure of the atom and Mendeleev's periodic law	2
4.	Determination of the types of chemical bonds between atoms in compounds. The relative electronegativity of atoms.	2(0,5)
5.	Determination of the thermal effect of the neutralization and dissolution of anhydrous salts.	2
6.	Calculation of kinetic parameters of the reaction according to the experiment.	2
7.	Determination of the conductivity of electrolyte solutions. Indicator method of pH solutions calculation.	2(0,5)
8.	The preparation of solutions given concentration	2
9.	The properties of metals in redox reactions.	2
10.	The dependence of electromotive force from galvanic cells	2

	of metals.	
11.	Investigation of electrolysis of aqueous solutions of electrolytes. The calculations of the aount of substances using Faraday's law.	2(0,5)
12.	Determination of corrosion mass index rate.	2(0,5)
13.	The chemical properties of metals and their compounds.	2(0,5)
14.	The genetic link between the classes of organic compounds, the methods of detection og organic compounds.	1(0,5)
15.	The properties of polymers. Introduction to methods of determining the quality of fuels.	2(0,5)

30hours (4hours)

4. **Independent work topics**

№	Topic title	Number of hours
Content Module 1. **The basics atomic-molecular theory of the matter structure**		
1.	Structure of molecules and methods of their research	2
2.	The importance of chemistry for the modern national economy and ecology	2
3.	The main directions of chemicalization of the agro-industrial complex	2
4.	Crystallization as a purification method	2
5.	From the craft of chemistry to chemical technology	2
6.	Allotropic modifications of Oxygen	2
7.	Basic concepts of chemistry	2
8.	The wonderful world of diamonds	2
9.	The main minerals of Ukraine	2
10.	The effect of radiation on living organisms: norms, doses, protection, problems	2
11.	Chemical bond	1
12.	Chemistry and solution of raw material and energy deficit	2
13.	Agrochemistry is an interdisciplinary science.	1
14.	Biogeochemistry is a new branch of natural sciences	2
15.	Liquid crystals and their application prospects in industry	2
Content Module 2. **Basic patterns of chemical processe**		
1.	Chrome plating of metal structures	2
2.	Manganese-zinc galvanic elements	1
3.	Hydrogen energy. Application prospects	1
4.	Passivation of metals	1
5.	Prospects for the use of lithium-ion batteries	1
6.	Anti-corrosion coatings in construction.	1
7.	Catalytic and electrochemical processes	1
8.	Water. Water hardness	1

9.	Peculiarities of changes in the chemical composition of groundwater in the conditions of economic activity	2
10.	Study of physical and chemical properties of drinking water	2
11.	Hydrolysis of salts	1
12.	Lead-acid batteries. Possibilities of use	1
13.	Non-polar solvents in construction	2
14.	Refining of metals	2
15.	Galvanostegia	2
16.	Electroplating	2
17.	Protective anodizing	2
18.	Electrochemical painting of metal parts	2
Content Module 3. **Chemistry of elements and compounds of elements that make up the basis of inorganic and organic building materials**		
1.	Polymers in structural materials	1
2.	Composite materials and their significance for the national economy	1
3.	Important zinc compounds, structure and properties	1
4.	The importance of chemistry in the creation of new materials	1
5.	Copper and its alloys	1
6.	Deformable aluminum alloys	1
7.	The influence of technological additives on the structure and properties of rubber	1
8.	Properties and applications of chromium and its compounds	1
9.	Nanotechnology. Development prospects	1
10.	Tin, its compounds and applications	1
11.	Polymethyl methacrylate. Plexiglass	1
12.	Non-ferrous metals and alloys	1
13.	Ceramics	1
14.	What is better - polymer or metal?	1
15.	Nanowires and other materials in the nanoworld	1
16.	Natural polymers in structural materials	1
17.	Alternative energy, development and prospects of implementation	1
18.	Calcium bioelement	1
19.	Coal and its processing products	1
20.	Natural, associated petroleum gas. Their composition. Oil	1

8. Samples of control questions, tests for assessing the level of knowledge acquisition by students.

Module №1

«Atomic structure and chemical bond»

Variant № 1

1. The possible values of main(principal) quantum number are:

A.	integers from 0 to n-1;	B.	+½, - ½;

C.	integers from 1 to ∞;	D.	integers from + *l* to - *l* .

2. The total number of orbitals in an s-subshell is?….. :

(write right answer to the answer sheet)

3. Which electron configuration reprsents an atom Sb in the ground state:

A.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^3$;	B.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2 5p^6 5d^{10}$;
C.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^8 5s^2 5p^5$;	D	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^1 5p^4$

4. To give the characteristics of elements:

№ 17, № 50

Scheme of answer:

- To determine (according to the placement of element in the periodic system):
- element properties - metal or non-metal;
- the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of elements.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 30and 8, specify the type of chemical bond of obtained compound

6.Determine the types of chemical bonds for the following compounds:

manganese; potassium carbonate; phosphate acid; calcium hydroxide; ferrum (III) sulfate

Variant № 2

1. What's formula determine value of secondary(azimunthal) quantum number:

A.	$2l + 1$;	B.	$2n^2$;	C.	$2(2l + 1)$;	D.	$0 \div n-1$.

2. Electronic structure of atom Manganese ….. :

(write right answer to the answer sheet)

3. The total number of shells (levels) of atom is equal to the number of..:

A.	Group ;	B.	Element;
C	Period;	D	Series.

4. To give the characteristics of elements:

№ 15, № 40

Scheme of answer:

- To determine (according to the placement of element in the periodic system):
- element properties - metal or non-metal;
- the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 16 and 19, specify the type of chemical bond of obtained compound

6.Determine the types of chemical bonds for the following compounds:

steel; chrome (III) nitrate; silicate acid; carbon (IV) oxide; chlorine

Variant № 3

1. The total number of orbitals in an f-subshell is:

A.	7;	B.	3;	C.	5;	D.	1.

2. The orientation of an orbital inspace is specified by ……. quantum number:

(write only one word to the answer sheet)

3. Which electron configuration reprsents an atom Zr in the ground state:

А.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2 5p^2$;	В.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2 4p^6 5s^2 5p^4$;
Б.	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^2 5s^2$;	Г	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^3 5s^1$

4. To give the characteristics of elements:

№ 7, № 23

Scheme of answer:

- To determine (according to the placement of element in the periodic system):
- element properties - metal or non-metal;
- the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 7 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:

barium chlorate; potassium carbonate; 2 molecule of fluoride acid; zinc hydroxide; scandium

Module №2

«The bases of electrochemistry»

Variant № 1

1. **Specify the number of lost or attached electrons according to the scheme $HNO_3 \rightarrow NH_3$:**
   A. +2, **B.** -2, **C.** -3, **D.** +8.
2. **To write molecular, complete and net ionic equations:**
   $ZnCl_2 + K_3PO_4 \rightarrow$ $Ba(NO_3)_2 + H_2SO_4 \rightarrow$
   $K_2SiO_3 + HCl \rightarrow$ $Fe_2O_3 + HNO_3 \rightarrow$
   $Zn(OH)_2 + Ca(OH)_2 \rightarrow$ $(NH_4)_2SO_4 + NaOH \rightarrow$
   $Ba + H_2SO_{4\ conc.} \rightarrow$ $Mn + HNO_{3\ dil.} \rightarrow$
   $Cu + HCI \rightarrow$ $Na + H_2O \rightarrow$
   $Al + NaOH \rightarrow$ $Zn(CH_3COO)_2 + Mg \rightarrow$
3. **To calculate EMF for the Fe-Cu galvanic cell:**
   A. 1,92 V **B.** -1,92 V **C.** 2,8 V, **V.** -2,8 V
4. **Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of potassium sulfate and melt sodium chloride?**
5. **Calculate amount of Copper on the cathode during electrolysis of aqueous solution of nickel sulfate for 30 minutes at a current 2A??**
   A. 71,6 g **B.** 4,12 g, **C.** 2,38 g, **D.** 1,19 g.

Variant № 2

1. **Specify the number of lost or attached electrons according to the scheme $HNO_3 \rightarrow HNO_2$:**
   A. +2, **B.** -2, **C.** +1, **D.** +8.
2. **To write molecular, complete and net ionic equations::**
   $CoCl_2 + Na_3PO_4 \rightarrow$ $BaCl_2 + H_2SO_4 \rightarrow$
   $K_2SO_3 + HNO_3 \rightarrow$ $NH_4NO_3 + NaOH \rightarrow$
   $Al(OH)_3 + NaOH \rightarrow$ $Cr_2O_3 + HClO_4 \rightarrow$
3. **To calculate EMF for the Zn-Cu galvanic cell:**
   A. 0,1 V **B.** -0,78 V, **C.** 0,78 V, **D.** 1,1 V.

4. **Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of plumbum nitrate and melt of potassium chloride?**
5. **Calculate amount of Nickel on the cathode during electrolysis of aqueous solution of nickel sulfate for 80 minutes at a current 5A?**

A. 1,83g **B.** 14,7 g, **C.** 7,3 g, **D.** 2,23 g.

Module №3

« Chemistry of the elements»

Variant № 1

1. **To write the dissociation equation for the ions of the following compounds:** ferrum (III) carbonate, itric acid, potassium hydroxide.
2. **Specify the number of lost or attached electrons according to the scheme** $NO_3^- \rightarrow NH_3$**:**

А. +2, **Б.** -2, **В.** -3, **Г.** +8.
3. **Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:**

$Ba + H_2SO_{4\ conc.} \rightarrow$ $Mn + HNO_{3\ dil.} \rightarrow$

$Cu + HCI \rightarrow$ $Na + H_2O \rightarrow$

$Al + NaOH \rightarrow$ $Zn(CH_3COO)_2 + Mg \rightarrow$

4. Determine reactions of oxygen depolarization of iron:

1.	$Fe - 2\ \bar{e} \rightarrow Fe^{2+}$;	**3.**	$1/2O_2 + H_2O + 2\ \bar{e} \rightarrow 2OH^-$;
2.	$Fe^{2+} + 2\ \bar{e} \rightarrow Fe$;	**4.**	$2H^+ + 2\ \bar{e} \rightarrow H_2$.

Variant № 2

1. **To write the dissociation equation for the ions of the following compounds:** Aluminium hydroxide, mangane (II) chloride, sulfate acid.
2. **Specify the number of lost or attached electrons according to the scheme** $NO_3^- \rightarrow NO_2$**:**

А. +2, **Б.** -2, **В.** +1, **Г.** +8.
3. **Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:**

$Ca + H_2SO_{4\ conc.} \rightarrow$ $Cu + HNO_{3dil.} \rightarrow$

$Au + HCI \rightarrow$ $Ba + H_2O \rightarrow$

$Cr + NaOH \rightarrow$ $Cu(CH_3COO)_2 + Zn \rightarrow$

4. Point the correspondence of the coating and processes:

A	Non-damage	**1.**	(C) $Zn^{2+} + 2\ \bar{e} \rightarrow Zn$;	**3.**	(C) $Fe^{2+} + 2\ \bar{e} \rightarrow Fe$;
B	damaged	**2.**	(A) $Fe - 2\ \bar{e} \rightarrow Fe^{2+}$;	**4.**	(A) $Zn - 2\ \bar{e} \rightarrow Zn^{2+}$.

9. Teaching methods.

In conducting lectures appropriate to use verbal teaching methods: explanation, narration, discussion, educational debate, with a combination of visual learning methods: illustration, showing. In carrying out laboratory work should be

used such as verbal learning method of instruction on the combination of visual learning methods of illustration and demonstration, the aspect of these studies is that they facilitate communication theory and practice. Laboratory work in the laboratory are equipped basic chemical and electrochemical equipments.

10.Forms of assessment

The main methods of control of knowledge and skills students have to study the subject "Remote sensing for land resources monitoring" are: oral examination, written and practical test, standardized control in the form of modular test papers, assessment for individual learning task, the final test. The total value of these methods is to make the best possible to ensure timely and comprehensive feedback between students and teachers, by which establishes how students perceive and learn the material. The purpose determines the choice of control methods, it should be borne in mind that these methods can be applied in all kinds of control - only complete applications allows regularly and objectively identify the dynamics of the formation of knowledge and skills of students. Each control method has its advantages and disadvantages, scope of application, none of them can not be the only one able to diagnose all aspects of the learning process. So: - to control the absorption of lectures: oral questioning, written modular test papers, current testing score for an individual learning task, the final test. - for the monitoring and evaluation of laboratory work: practical test and evaluation of each laboratory work.

10. Distribution of grades received by students during study.

5. **Distribution of grades received by students.** Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 03.03.2021, protocol №7)

Student rating, points	**National grade based on exam results**	
	Exams	**Credits**
90-100	**Excellent**	**Passed**
74-89	**Good**	
60-73	**Satisfactory**	
0-59	**Unsatisfactory**	**Not passed**

In order to determine the rating of a student (listener) in the discipline $\mathbf{R_{dis}}$ (up to 100 points), the rating from the exam $\mathbf{R_{ex}}$(up to 30 points) is added to the rating of a student's academic work $\mathbf{R_{aw}}$ (up to 70 points): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$.

11.Educational and methodological support.

List of visual and other teaching and methodical aids, methodical materials.

№	Name	Quantity
1	2	4
1.	Slides (electronic form) for the lecture course	1 note
2.	Tutorial	Electronic version

12. Recommended sources of information

12. Basic literature

1. David R. Klein. Organic Chemistry, 4th (January 5, 2019) 1st edition. Wiley. – 1390p.
2. General and Inorganic Chemistry: Textbook / V. O. Kalibabchuk [et al.] ; ed. V. O. Kalibabchuk. – Kyiv : AUS Medicine Publishing, 2019. – 455 p.
3. Основи загальної та неорганічної хімії: навчальний посібник. Перевидання / Н. М. Антрапцева, О. Д. Кочкодан. - К. : ФОП Ямчинський О.В., 2020. - 331 с.
4. Органічна, біоорганічна, фізична і колоїдна хімія: навчальний посібник / В. В. Кротенко, Л. О. Ковшун ; Національний університет біоресурсів і природокористування України. - Перевидання. - К. : НУБіП України, 2022. - 425 с.
5. Антрапцева Н.М., Кравченко О.О., Солод Н.В. Chemistry. Methodological guidelines for laboratory practice execution for students speciality: 192 – Construction and Civil Engineering ". - Видавничий центр « Експо-Друк », 2022. – 160 с.
6. Антрапцева Н.М., Солод Н.В., Кравченко О.О. Chemistry. Methodical guidelines for the English-language course mastering for students of technical direction. - К.: Видавничий центр «»Експо-Друк, 2018. - 151 с.
7. Антрапцева Н.М., Жила Р.С. Хімія. Методичні вказівки з лабораторного практикуму для студентів спеціальності 192 – Будівництво та цивільна інженерія. Ступінь освіти «Бакалавр». К.: ДДП «Експо-Друк», 2022. 160 с.
8. Антрапцева Н.М., Кочкодан О.Д., Жила Р.С. Хімія. Тестові завдання для самостійної роботи студентів спеціальностей: 151 – Автоматизація та комп'ютерно-інтегровані технології, 133 – Галузеве машинобудування, 192 – Будівництво та цивільна інженерія. К.: НУБіП, 2019. – 160 с.

Supplemental materials

1. Arthur Winter. Organic Chemistry I For Dummies, 3nd Edition, 2019. – 384 p.
2. Хімія: навчальний посібник для студентів спеціальності 201 "Агрономія" скороченого терміну навчання / В. В. Кротенко, О. І. Хижан, Л. О. Ковшун ; Національний університет біоресурсів і природокористування України. - К. : НУБіП України, 2019. - 429 с.

13. IT resources

1. https://ptable.com/
2. https://learningapps.org/
3. https://chemequations.com/en/
4. https://learningcenter.unc.edu/services/stem/chemistry-resources/
5. https://edu.rsc.org/
6. https://bioapi.lk/chemistry-resource-book-sinhala-bioapi/
7. http://simplescience.ru/video/about:chemistry/
8. http://chemistry-chemists.com/Video.html
9. https://www.youtube.com/c/Thoisoi/
10. https://www.youtube.com/c/ChemistryEasy/
11. http://simplescience.ru/video/about:chemistry/
12. http://chemistry-chemists.com/Video.html
13. http://www.chemicum.com/ru/
14. https://www.youtube.com/channel/UCD2fRmgV93G8ZUxZTGLbScA