NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

AGROBIOLOGICAL FACULTY
DEPARTMENT OF ANALYTICAL AND BIOINORGANIC CHEMISTRY & WATER QUALITY

"APPROVED"

Dean of the Faculty of Plant Protection,
Biotechnology and Ecology
Dr.Agr.Sc., Prof._____M.M. Doliia
"___"_ _ 2015

REWIED AND APPROVED
At the meeting of the department
of Analytical and Bioinorganic
Chemistry & Water Quality
Protocol # 5 "_23_" __November__2015
Head of the Department
Dr.Chem.Sc., Prof._____V.A. Kopilevich

SYLLABUS

Academic Discipline "ANALYTICAL CHEMISTRY"
For EQL "Bachelor" 6.090105
Specialty - Plant protection

Syllabus compiled by : Associate Professor N. Prokopchuk, PhD in Chemistry

Kyiv, 2016

working program ___Analytical Chemistry_____for students of direction 6.090105 – Plant protection.

_23_ ”__November__2015

The developers: N.M. Prokopchuk, Associated Professor of the Department of Analytical and Bioinorganic Chemistry & Water Quality, PhD in Chemistry
(вказати авторів, їхні посади, наукові ступені та вчені звання)

The working program was approved at the meeting of the Department of Analytical and Bioinorganic Chemistry & Water Quality _____-_____
_____
___

Protocol # 5 “_23_ ”__November__2015
Head of the Department of ___ Analytical and Bioinorganic Chemistry & Water Quality , Dr.Chem.Sc., Prof.

_____ (_V.A. Kopilevich_)
(підпис) (прізвище та ініціали)
“_____”_____ 20___ .

Approved by the Scientific Council of Plant Protection, Biotechnology and Ecology Faculty
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Protocol # ___ “____”_____20___ .

“_____”_____20__ p. Head _____
(_____)
(підпис) (прізвище та ініціали)

1. Academic discipline description

Analytical Chemistry

(назва)

Field of knowledge, direction, specialty, education and qualification level		
Educational and Qualification level qualification	bachelor	
Direction	6.090105 – Plant protection	
Area of training	0401 – natural sciences	
Characteristics of training programme		
Type	ordinary	
The total number of academic hours	90	
Number of ECTS credits allocated	3	
Number of modules	2	
Forms of control	Test	
Indicators of academic discipline for full-time and part-time forms of training course		
	Full-time	**Part-time**
Year (course)	1	
Semester	2	
Number of lectures	15	
Number of seminars, practical classes		
Laboratory sessions (activities)	45	
Independent study	30	
Individual lessons		
Number of weekly in-class academic hours for full-time forms of training	3	

1. Goal and objectives of academic discipline

Analytical Chemistry is a fundamental subject, obligatory to studding for students of agricultural specialties of Higher Educational Agrarian Universities of III-IV accreditation levels. This program was developed on the base of Educational Program of Subject "Chemistry" for specialty "Plant Protection" (direction "Plant Protection").

In the modern society Analytical Chemistry is a powerful source of productive powers. In particular, intensification of scientific-technical progress in agricultural production requires a rational use of chemical science achievement, Intensification of ecological control of economy activity.

The main tasks of analytical chemistry are:

- - A studding of it as a transition from fundamental to special subjects of training of specialists theoretical and experimental foundations for a studding of professional-oriented and special subjects (Agrochemistry, Soil Sciences, Plant growing, Agrochemical Analysis, Soil Science, Agroecology, Chemical Plant Protection et al.);
- Assimilation of the main skills of qualitative and quantitative chemical analyses and mathematical calculations of their results.

Requirements of knowledge and skills acquired during studying the subject.

In the result of studding of analytical chemistry a student of Bachelor Course in Plant Protection must:

To know foundations of main methods of qualitative and quantitative chemical analyses, traditional laboratory equipment, and chemical dishes, materials and reagents for an analytical determinations;

To know how use an educational, methodical and reference literature sources in the field of analytical chemistry, to prepare equipment, dishes, reagents for a analysis; to do qualitative and quantitative chemical analyses according to methodical rules; to carry out a mathematical processing of quantitative analyses, to estimate a inaccuracy of analysis; to present results of experimental exercises in the form of protocol in the field of agronomy, plant protection;

Control of knowledge and skills is realized in the form of defense of laboratory exercises in oral form, written control tests of theoretical knowledge and final written exam.

Teaching of subject is organized according to module-rating principle for more objective and ranked an estimation of student's knowledge.

1. CONTENT OF SUBJECT

Titles, contents and extents of lectures.

Змістовий модуль 1. Principles and methods of Qualitative Analysis of Cations and Anions.

Lecture # 1. Introduction. Subject and tasks of Analytical Chemistry. Principles of Qualitative Analysis and its terminology. Methods of analytical reactions doing.

Analytical chemistry as the branch of chemistry. Separation and analysis of chemical substances. Qualitative and quantitative analysis. Semimicro techniques. Dispensing reagent solutions. Stirring rods. Adjusting pH. Precipitation. Centrifuging. Analytical techniques.

Lecture # 2. Classification of cations of the main bio-active metals and toxic metals according to phosphate-ammonium method. Qualitative reactions.

General ideas of qualitative analysis. Analytical reagents, group reagents, specific reagents, selective reagents. The sensitivity of the reactions, detectible minimum (m), concentration limit (c), maximum dilution (MD). Principles of amino-phosphate classification of cations. Qualitative analysis of cations. Classification of anions. Qualitative analysis of anions. Analysis of unknown substances. Identifying a simple salt by logistics way. Identifying a simple salt by step-by-step way.

Змістовий модуль 2. Theoretical and experimental foundations of Quantitative chemical analysis. Gravimetry and neutralization method. Red Ox methods and complexing methods.

Lecture # 3. Quantitative chemical analysis as a branch of analytical chemistry. Quantitative chemical analysis as a branch of analytical chemistry. The major types of chemical methods as gravimetric analysis (q.v.) and volumetric, or titrimetric, analysis. The basic tools in all quantitative analyses. Units of concentration: Percent by Mass (mass concentration, percent concentration, parts per million (ppm), parts per billion (ppb), parts per trillion (ppt)), Molarity (molar concentration) (M), Mole Fraction (X), Molality (m), Normality (normal concentration). Dilutions.

Lecture # 4. Chemical equilibrium in heterogeneous systems.
Chemical equilibrium in heterogeneous systems. Precipitation reactions. The solubility product. Ionic product. Molar solubility and solubility. Predicting precipitation reactions. The common ion effect and solubility.

Lecture # 5. Chemical equilibrium in homogeneous systems.
Chemical equilibrium in homogeneous systems. Law on mass action in reversible reactions. Constant of chemical equilibrium. Osvald's delusion law. Hydrogen power. Buffer solutions and their application. Titrimetry. Neutralization method.

Lecture # 6. Theoretical notions of RedOx titration methods (Redoxmetry).

General principles of Redoxmetry. Half-reactions. Quantitative characteristic of direction and completeness of passing of Oxidation-Reduction reaction. Standard redox potentials. Curves of redoxmetry. Titrating solutions and indicators in methods of redoxmetry.

Lecture # 7. Theoretical notions of Complexonometry and Argentometry.
Helators. Determination of titration endpoint.

4. Subject Structure

3. PROGRAM AND STRUCTURE OF THE SUBJECT

Назви змістових модулів і тем	Кількість годин											
	денна форма						Заочна форма					
	усього	у тому числі					усього	у тому числі				
		л	п	лаб	інд	с.р.		л	п	лаб	інд	с.р.
1	2	3	4	5	6	7	8	9	10	11	12	13
Змістовий модуль 1. **Principles and methods of Qualitative Analysis of Cations and Anions**												
Тема 1. Introduction. Subject and tasks of Analytical Chemistry. Security techniques. Principles of Qualitative Analysis and it terminology. Methods of analytical reactions doing.		2		2								

Тема 2. Classification of Cations of the main bio-active metals and toxic metals according to phosphate-ammonium method. Qualitative reactions and methods for distribution of I (NH_4^+; K^+; Na^+) and III (Cu^{2+}; Zn^{2+}) analytical groups of cations.		1		4		4						
Тема 3. Qualitative reactions and methods for distribution of II group of cations (Mg^{2+}; Ca^{2+}; Sr^{2+}; Mn^{2+}; Fe^{2+}; Fe^{3+}; Al^{3+}).				4		2						
Тема 4. Control test: Qualitative reactions and methods for distribution of I - III groups of cations.				2								
Тема 5. Qualitative reactions and methods for distribution of I - III groups of anions (SO_4^{2-}; SO_3^{2-}; CO_3^{2-}; PO_4^{2-}; Cl^-; Br^-; J^-; NO_3^-; NO_2^-; CH_3COO^-).		1		4		2						
Тема 6. Experimental tests: Qualitative Analysis of three unknown compounds (salts or acids or oxides with different solubility in water).				4		2						
Тема 7. Control test: Qualitative Analysis of three unknown compounds.				2								

Разом за змістовим модулем 1		4		22		10						
Змістовий модуль 2. **Theoretical and experimental foundations of Quantitative chemical analysis. Gravimetry and neutralization method. Red Ox methods and complexing methods.**												
Тема 1. Methods of qualitative analysis: weighting, using of measuring dishes, filtration, desiccation, heating of precipitates. Features of calculations in gravimetry on the example of barium content analysis in polluted barium chloride.		4		4		4						
Тема 2. Techniques of Qualitative Analysis. Initial and working solutions in methods of titrimetric analysis. Standard tubes fiksanals). Calculations in titrimetric analysis. Preparation of chemicals for neutralization method.		2		4		4						
Тема 3. Experimental tests: neutralization method: Analysis of alkali solution and calculation of its concentration; temporary hardity of water determination.		2		4		4						
Тема 4. Control test: neutralization method and concentration of solutions.				2								
Тема 5. Theoretical		2		3		4						

foundations and experimental using of permanganate method. Experimental test: permanganate method: - determination of iron (II) content in More salt.												
Тема 6. Theoretical foundations and experimental using of EDTA method. Experimental test: EDTA method: - determination of calcium content in soil solution; - determination of total hardity of water.		1		4		4						
Разом за змістовим модулем 2		11		23		20						
Усього годин		15		45		30						

5. Теми лабораторних робіт

№ з/п	Назва теми	Кількість годин
1	Introduction. Subject and tasks of Analytical Chemistry. Lab. Safety rules. Principles of Qualitative Analysis and it terminology. Methods of analytical reactions doing.	2
2	Classification of Cations of the main bio-active metals and toxic metals according to phosphate-ammonium method. Qualitative reactions and methods for distribution of I (NH_4^+; K^+; Na^+) and III (Cu^{2+}; Zn^{2+}) analytical groups of cations.	4 4
3	Qualitative reactions and methods for distribution of II group of cations (Mg^{2+}; Ca^{2+}; Sr^{2+}; Mn^{2+}; Fe^{2+}; Fe^{3+}; Al^{3+}).	4
4	Control test: Qualitative reactions and methods for distribution of I - III groups of cations.	2
5	Qualitative reactions and methods for distribution of I - III groups of anions (SO_4^{2-}; SO_3^{2-}; CO_3^{2-}; PO_4^{2-}; Cl^-; Br^-; J^-; NO_3^-; NO_2^-; CH_3COO^-).	4
6	Experimental tests: Qualitative Analysis of three unknown compounds (salts or acids or oxides with different solubility in water).	4
7	Control test: Qualitative Analysis of three unknown compounds.	2
8	Methods of qualitative analysis: weighting, using of measuring dishes, filtration, desiccation, heating of precipitates. Features of calculations in	2

	gravimetry on the example of barium content analysis in polluted barium chloride.	
9	Techniques of Qualitative Analysis. Initial and working solutions in methods of titrimetric analysis. Standard tubes fiksanals). Calculations in titrimetric analysis. Preparation of chemicals for neutralization method.	2
10	Experimental tests: neutralization method: Analysis of alkali solution and calculation of its concentration; temporary hardity of water determination.	4
11	Control test: neutralization method and concentration of solutions.	2
12	Theoretical foundations and experimental using of permanganate method. Experimental test: permanganate method: determination of iron (II) content in More salt.	2 3
13	Theoretical foundations and experimental using of EDTA method. Experimental test: EDTA method: - determination of calcium content in soil solution; determination of total hardity of water.	2 2

5. Independent study

#	Name of theme	Number of hours
1	Molar ratios, molar masses, balancing and interpreting equations, conversions between grams and moles.	1
2	The electronic arrangements and dots-and-crosses diagrams.	2
3	Atomic number as the basis for the Periodic Law. Long form periodic table.	2
4	Lewis Structures. Exceptions to Regular Lewis Structures - resonance structures	5
5	Catalysts and catalysis. Dynamic equilibria.	1
6	Colligative properties of solution.	1
7	Dilute concentrations units: ppm, ppb,ppt.	1
8	Use of Hydrolysis in the "Real World".	3
9	Lewis Acid-Lewis base approach to bonding in complexes.	2
10	Half-reactions. Nernst Equation.	2
11	Metal halides. Interhalogen compounds.	2

12	Allotropes of Oxygen and Sulfur.	4
13	Occurrence of pnictogens.	2
14	Properties of alkali and alkali-earth elements.	2
	Totally	**30**

6. Test questions for final assessment

Екзаменаційні питання	
1. Atomic structure. Quantum numbers of electrons in atoms. Write complete electron configuration of the Sulfur atom and draw all possible exited states. Note valences, maximum and minimum oxidation numbers of this element.	
2. Bases. Classification, preparation and examples of bases. Which substances may react with each other: P_2O_5, NaOH, ZnO, HF, CaO? Write corresponding reactions.	
Тестові завдання	
1. Which formula contains error?	
A. $CaHSO_4$	**C. NH_4HSO_4**
B. $(NH_4)_2SO_4$	**D. $CaHPO_4$**
2. Point the correspondence between formula of compound and type of a chemical bond:	
A. $BaCl_2$	**1. A metallic bond**
B. Zn	**2. An ionic bond**
C. O_2	**3. A non-polar covalent bond**
D. NH_3	**4. A polar covalent bond**
A._____, B._____, C._____, D._____.	
3. Percent by mass of solution contained 15 g of $(NH_4)_2SO_4$ in 250 g of water, is:	
A. 3,9%	**C. 4,8%**
B. 1,5%	**D. 5,7%**
4. What is it necessary to add to K_3PO_4, so that K_2HPO_4 can be formed:	
A. KOH	**C. H_2SO_4**
B. KCl	**D. H_3PO_4**
5. Write all possible reactions between $Ba(OH)_2$ and H_2SO_4 (taking into account the possibility of neutral, acidic and basic salts forming).	
6. Note oxidation number and coordination number of the central atom in the complex compound - $[Cr(NH_3)_5Br]SO_4$.	
A. +2, 4	**D. +3, 6**

B. +2, 6	**E. +4, 6**
C. +3, 4	
7. Complete Redox reaction. Write electron balance. Determine oxidizing and reducing agents calculate sum of coefficients in equation: **$Ca + H_2SO_{4(conc.)} \rightarrow$**	
A. 16	**C. 17**
B. 18	**D. 10**
8. Calculate a sum of coefficients in the molecular equation for 1st step hydrolysis of Zinc Sulfate and write molecular, complete ionic, and net-ionic reactions.	
A. 8	**C. 6**
B. 4	**D. 7**
9. What substances are strong electrolytes? **$Zn(OH)_2$ 2. HNO_3 3. HClO 4. HF 5. CH_3COOH 6. $CaCl_2$**	
A. 1 i 4	**D. 3 i 5**
B. 2 i 6	**E. 2 i 3**
C. 3 i 4	
10. Bonds of central atom with ligands in complex compounds are realized due to:	
A. Ionic bond;	**C. Covalent bond;**
B. Donor-acceptor covalent bond;	**D. Metallic bond.**

7. Teaching Methods

A **teaching method** comprises the principles and methods used for teaching. Commonly used teaching methods for studying subject Water Resources Management include class participation, demonstration, recitation, memorization, or combinations of these. The choice of teaching method or methods to be used depends largely on the information or skill that is being taught, and it may also be influenced by the aptitude and enthusiasm of the students.

Explaining, or lecturing, is the process of teaching by giving spoken explanations of the subject that is to be learned. Lecturing is often accompanied by visual aids to help students visualize an object or problem.

Demonstrating is the process of teaching through examples or experiments. For example, a science teacher may teach an idea by performing an experiment for students. A demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning.

Demonstrations are similar to written storytelling and examples in that they allow students to personally relate to the presented information. Memorization of a list of facts is a detached and impersonal experience, whereas the same information, conveyed through demonstration, becomes personally relatable. Demonstrations help to raise student interest and reinforce memory retention

because they provide connections between facts and real-world applications of those facts. Lectures, on the other hand, are often geared more towards factual presentation than connective learning.

Collaboration allows students to actively participate in the learning process by talking with each other and listening to other points of view. Collaboration establishes a personal connection between students and the topic of study and it helps students think in a less personally biased way. Group projects and discussions are examples of this teaching method. Teachers may employ collaboration to assess student's abilities to work as a team, leadership skills, or presentation abilities.

Collaborative discussions can take a variety of forms, such as fishbowl discussions. After some preparation and with clearly defined roles, a discussion may constitute most of a lesson, with the teacher only giving short feedback at the end or in the following lesson.

Learning by teaching is the method, when students assume the role of teacher and teach their peers. Students who teach others as a group or as individuals must study and understand a topic well enough to teach it to their peers. By having students participate in the teaching process, they gain self-confidence and strengthen their speaking and communication skills.

7. Forms of control

The main forms of knowledge control are control at the lectures at seminars and workshops, outside the classroom, at the consultations, tests and exams.
I. Control of the lectures can be conducted as a selective oral questioning of students or tests using the previously laid material, particularly in sections of the course that are necessary for the understanding of the lecture topics, read, or to establish a degree of mastery of the material lectures (held by the manner of the late first or early second hour lectures).
Testing during lectures designed to teach students to systematic elaboration covered material and prepare for the upcoming lectures, establish the degree of assimilation theory to identify the most difficult students to read chapters from the following explanation of them. Control of the lectures has to subtract time. By spending time to control oral examination yields control, programmable for cards.
II. Current control on practical, seminar and laboratory studies conducted to elucidate ready students for employment in the following forms:

1. Writing (45 min.) Control work.
2. Colloquium on separate sections of theoretical courses (modules or themes).

III. Credits. Some subjects (theoretical courses, practical training) is applied differential test of performance appraisal on a five point scale. In a lecture course or its individual parts, which are not accompanied by laboratory or practical classes, the teacher may conduct interviews or colloquium, offer oral or written

(with tickets) questions. TeacherUseful browse the students' notes. Often, students are subject to crediting as minor, insignificant and do not give enough time to prepare for it. Of the major courses before credit of Colloquium useful.

Term papers are the product of many days of work. They include elements of scientific research. Protecting course work - a special form of offset in the commission of two or three teachers. Best of coursework submitted for scientific student conference.

IV. Examinations. Exam is the final step in the study of the whole or part of the discipline and are designed to test students' knowledge on the theory and identify the skills apply the acquired knowledge in solving practical problems, as well as independent work skills with educational and scientific literature.

Student's rating of knowledge of an academic discipline consists of training work rating – 70 points and attestation rating – 30 points. Thus, rating of content modules, that are constituents of an academic discipline, makes 70 points. Rating of content modules as well as attestation rating are also measured by 100-point-scale.

Evaluation and grading

Grading system: National and ECTS

National grade	Оцінка ECTS	Grade according to national system	Percentage score
passed	**A**	Excellent	90 – 100
	B	Very good	82-89
	C	Good	74-81
	D	Satisfactory	64-73
	E	Satisfactory enough	60-63
Not-passed	**FX**	Unsatisfactory	35-59
	F	Unsatisfactory– serious work is needed	0-34

9. Technology and methodological requirements

1. Analytical Chemistry. Manual. Voytenko L., Kosmatiy V., Kopilevich V., - Kyiv: NAU Publish., 2014. - 199 pp.
2. Workbook on Analytical Chemistry. Voytenko L., Kosmatiy V., Kopilevich V., Prokopchuk N. - Kyiv: NAU Publish., 2014. - 1 pp.

10. Required and recommended literature

Basic

1. Introduction in General, Organic and Biochemistry, 7th Edition, by Morris Hein, Leo R. Best, Scott Pattison and Susan Arena, Brooks/Cole Publishing Co., 2001, 872 pp.
2. Chemistry: the Molecular Nature of Matter and Change, 2nd ed. Martin S. Silberberg, McGraw-Hill Companies, 2000, 1086 pp.
3. Chemistry. Raymond Chang, 6th ed., McGraw-Hill Companies, 1998, 993 pp.

4. Inorganic Chemistry, second edition, D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman and Co., New York, 1994, 913 pp.
5. Glinka N.N. General Chemistry. Moscow: Nauka, 1966, 432 pp.

Supplemental

1. Concepts and Models of Inorganic Chemistry, third edition, B. E. Douglas, D. H. McDaniel and J. J. Alexander; John Wiley & Sons, Inc., New York, 1994. 993 p.
2. Inorganic Chemistry, A Modern Introduction, T. Moeller; John Wiley & Sons, New York, 1982. 846 p.
3. Chemistry of the Elements, N. N. Greenwoo and A. Earnshaw; Pergamon Press, New York, 1984. 1542 pp.

11. Normative literature

1. ISO 6353-2:1983 Reagents for chemical analysis -- Part 2: Specifications -- First series.
2. ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method.
3. ISO 6059 – 1984 Water quality – Determination of the sum of calcium and magnesium – EDTA titrimetric method.

12. IT resources

1. http://www.informika.ru/text/database/chemy/Enu/Data/Ch1-7.html
2. http://dbhs.wvusd.k12.ca.us/AcidBase/Kw.html
3. http://dbhs.wvusd.k12.ca.us/AcidBase/Hydrolysis.html
4. http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/bond.html
5. http://chemlab.pc.maricopa.edu periodic/triangletable.html
6. http://www.pc.chemie.uni-siegen.de/pci/versuche/english/kapite14. html