The syllabus for discipline «ANALYTICAL CHEMISTRY»

1. General information	
Name ot the faculty	pharmaceutical faculty
Educational program	22 Health, 226 Pharmacy, industrial pharmacy, Second (master's) educational level, full-time course
Навчальний рік	2021-2022
Course title, code	Analytical chemistry, OK35,
Department (*address, phone, e-mail*)	Department of toxicological and analytical chemistry 79010, Lviv, Pekarska str., 69 +38 (032) 368437 kaf_toxchemistry@meduniv.lviv.ua
Head of department *(e-mail)*	Halkevych Irine, PhD, Associated professor, galkirin@meduniv.lviv.ua
Year of study	2nd year
Semester	III, IV semester
Type of discipline	Compulsary
Викладачі	1. Bidnychenko Yuriy, PhD, Associated professor; bidnyuri@i.ua 2. Davydovych Sofia, PhD, Assistant professor, ihlitska.sophia@gmail.com
Erasmus yes/no	no
Author	Halkevych Irine, PhD, Associated professor, galkirin@meduniv.lviv.ua Kramarenko Serhiy, PhD, Senior Lecturer, sergeikr@gmail.com Kostyshyn Lyubov, PhD, Senior Lecturer, kostyshynluba@gmail.com
Total credits ECTS	8.0 credits
Total number of hours	240 h (Lectures – 30 / Practical classes – 120 / ISW – 90)
Language	English
Інформація про консультації	Consultations at the department take place in accordance with the approved schedule of consultations
2. Course description (abstract)	
"Analytical chemistry" is intended for students of higher education institutions of the pharmaceutical profile of Ukraine and is an integral part of the state standard of education. This is a fundamental chemical discipline for methods for determining the qualitative and quantitative composition of compounds, their mixtures, as well as the establishment of the chemical structure of	

substances.

Analytical chemistry includes classic and modern chemical and physico-chemical methods of analysis, differing in speed and high sensitivity – spectrophotometry, chromatography, polarography, potentiometry and others.

Knowledge obtained by students in the process of studying analytical chemistry is a theoretical and practical basis for studying specialized disciplines at senior courses. Without knowledge of analytical chemistry, it is impossible to solve problems and problems of biological, pharmaceutical, toxicological chemistry, pharmacognosy and other disciplines, and mastering the methods of planning and performing analysis is necessary for students in their practical work.

3. Goals and objectives of the course

1. The purpose of teaching the discipline "Analytical chemistry" is to prepare students for the development of medical-biological and special disciplines, for which, based on modern scientific ideas, students develop the necessary knowledge, skills and skills in the field of analytical chemistry.

2. The main tasks of studying the discipline "Analytical Chemistry" are:

- formation of students of knowledge and skills, practical skills in analytical chemistry, which is the general theoretical basic discipline in the system of preparation of a pharmacist;
- pharmaceutical chemistry, as well as obtaining the basic chemical knowledge necessary for understanding and assimilating a number of medical, biological, and chemical disciplines studied at the pharmaceutical faculty.

3. **Competence and learning outcomes,** the formation of which is facilitated by discipline (the relationship with the normative content of the training of higher education graduates, formulated in terms of results of study in the Standard of Higher Education).

According to the requirements of the Standard discipline "Analytical chemistry" contributes to the acquisition of students competencies:

integral: ability to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity, applying the theoretical principles of the basics of chemical processes and methods of chemical and physical-chemical analysis (qualitative and quantitative) that involves conducting experimental research, introducing innovative methods of analysis, to reasonably justify the results of definitions and to unambiguously communicate their findings and knowledge to the professional and non-physical audience;

general:

- ability to apply knowledge in practical situations
- knowledge and understanding of the subject area and understanding of the profession;
- ability to abstract thinking, analysis and synthesis, ability to learn and master modern knowledge;
- skills of using information and communication technologies;
- the ability to evaluate and ensure the quality of performed work;
- ability to conduct research at the appropriate level;
- striving to preserve the environment;

special (professional, subject):

- ability to organize, provide and perform the analysis of the quality of medicinal products in pharmacy and pharmacy control and analytical laboratories in accordance with the State Pharmacopoeia and other regulatory acts;
- ability to test, biopharmaceutical research and methods of drug control;
- ability to determine the list of equipment and reagents for the quality control of medicinal products in accordance with the requirements of the State Pharmacological Center and other

regulatory documents;

- ability to prepare reagents for the analysis of drugs using chemical and physical-chemical methods;
- ability to develop methods for controlling the quality of medicinal products, pharmaceutical substances, medicinal plant raw materials and auxiliary substances using physical, physical, chemical and chemical methods of control;
- ability to interpret and evaluate the results of the analysis of medicinal products**.**

Detailing competencies according to the NRC descriptors in the form of the Competence Matrix.

4. Course prerequisites

Analytical chemistry as an educational discipline:

(a) is based on knowledge of inorganic chemistry, physics and mathematics and integrated with organic, pharmaceutical, toxicological, physical, colloid and biological chemistry;

(b) establishes the basis for the study of pharmaceutical and toxicological chemistry and involves the formation of skills for the use of the knowledge acquired for the study of special disciplines and professional activities.

5. Programm learning outcomes

List of learning outcomes

Code of learning outcomes	**Content of learning outcomes**	**Link to the code in the Competence Matrix**
Knowledge – Kn., Skill – Sk., Communication – C., Autonomy and responsibility – AR.		
General competencies		
Kn-1	Have specialized conceptual knowledge acquired in the learning process.	*ПР-2. Ability to apply knowledge in practical situations*
Sk-1	Be able to solve complex problems and problems that arise in professional activity.	
C-1	Clear and unambiguous communication of their own conclusions, knowledge and explanations, which substantiate them to specialists and non-specialists.	
AR-1	Responsible for acceptance decisions in difficult conditions	
Kn-2	Have deep knowledge of structure professional activity.	*ПР-6. Knowledge and understanding of the subject area and understanding of the profession*
Sk-2	Be able engage in professional activities that require updating and integration of knowledge.	
C-2	Ability to effectively shape communication strategy in professional activities.	
AR-2	Be responsible for professional development, the ability to further vocational training with a high level of autonomy.	
Kn-3	Know the methods of analysis, synthesis and further modern learning.	*ПР-4. Ability to abstract thinking, analyzing and synthesizing, being able to learn and be modern in learning.*
Sk-3	Be able to analyze information, make informed decisions, and be able to acquire modern knowledge.	
C-3	Establish appropriate links to achieve goals.	
AR-3	Be responsible for the timely acquisition of modern knowledge.	
Kn-4	Have deep knowledge in the field of information and communication technologies used in professional activity	*ПР-9. Use of information and communication technologies*
Sk-4	Be able to use information and communication technologies in the professional field that requires updating and integration of knowledge	

C-4	To use information and communication technologies in professional activity	
AR-4	Be responsible for the development of professional knowledge and skills	
Kn-5	Know the methods of evaluating performance indicators	*ПР-11. Ability to evaluate and ensure the quality of work performed*
Sk-5	Be able to provide quality work	
C-5	Establish links to ensure the quality of work	
AR-5	Be responsible for quality work	
Kn-6	Know the components of the health care system, plan and evaluate research	*ПР-12. Ability to conduct research at an appropriate level;*
Sk-6	Search for scientific sources of information; to choose the methods of scientific research, to use the methods of mathematical analysis and modeling, theoretical and experimental research in pharmacy	
C-6	Use information from scientific sources	
AR-6	Be responsible for the development and implementation of planned projects	
Kn-7	Know the problems of environmental conservation and how to conserve it	*ПР-3. The desire to preserve the environment*
Sk-7	Be able to formulate requirements for yourself and others for environmental protection	
C-7	Make proposals to the relevant authorities and agencies on conservation and environmental protection measures	
AR-7	Be responsible for the implementation of environmental measures within its competence	
Special (specialized, subject) competences		
Kn-8	Know the modern requirements for organizing and ensuring quality control of medicines in the pharmacy and pharmacy business.	*ПР-__*. Ability to organize, provide and perform an analysis of the quality of medicinal products in pharmacy and pharmacy control and analytical laboratories in accordance with the requirements of the State Pharmacopoeia and other regulatory acts.
Sk-8	Be able to choose chemical and physical-chemical methods for analyzing the quality of medicinal products.	
C-8	To substantiate the methods of analysis of pharmaceutical products in a pharmacy and pharmaceutical company.	
AR-8	Be responsible for the quality control of drugs in a pharmacy and pharmacy.	
Kn-9	Know the chemical and instrumental methods of analysis.	*ПР-__*. Ability to test, biopharmaceutical research and drug control methods.
Sk-9	Be able to apply chemical and instrumental methods of analysis, conduct biopharmaceutical research for the control of medicinal products.	
C-9	Be able to apply chemical and instrumental methods of analysis, conduct biopharmaceutical research for the control of medicinal products.	
AR-9	Be responsible for the decision on the evaluation results of chemical, physico-chemical and biopharmaceutical control methods of medicines.	

Kn-10	Know the requirements of the State Pharmacopoeia and other normative documents.	*ПР-14.* Ability to determine the list of equipment and reagents for the organization of quality control of medicinal products in accordance with the requirements of the State Pharmacopoeia and other normative documents.
Sk-10	Be able to prepare the necessary reagents and work with modern equipment of chemical laboratories.	
C-10	Provide lab work as required quality control and other regulations.	
AR-10	Responsible for organizing the quality control of medicines accordance with quality control and other normative documents.	
Kn-11	Know the chemical and advanced instrumental methods of analysis; know the specificity and sensitivity of different research methods.	*ПР-32.* Ability to prepare reagents for the analysis of drugs using chemical and physicochemical methods.
Sk-11	Be able to choose the methods of research of medicinal products and prepare reagents for analysis.	
C-11	Argument choosing of analysis methods.	
AR-11	Be responsible for the results of analysis of drugs.	
Kn-12	Know: - qualitative analysis of cations and anions; - medicinal substances of inorganic nature; - general methods of analysis of inorganic and organic drug compounds; -chemical titrimetric methods of analysis; -chromaticographic methods of identification and quantification of substances; -the distribution of light in matter, methods of luminescent analysis; -optical activity and specific rotation; -gravimetric method of analysis; -the main concepts of the titrimetric analysis; -spectral analysis methods.	Ability to develop methods for quality control of drugs, pharmaceutical substances, and auxiliary substances using physical, physical, chemical, and chemical methods of control.
Sk-12	To develop methods of quality control of pharmaceutical products.	
C-12	Be responsible for the validity of developed quality control methods.	
AR-12	Responsible for the organization of chemical investigations in accordance with regulatory documents	
Kn-13	Know the standard statistical analysis procedures.	Ability to interpret and evaluate the results of the analysis of drugs.
Sk-13	Be able to substantiate the size of the sample, apply static analysis methods, and give results of statistical data processing.	
C-13	Reasonable to evaluate the results obtained.	
AR-13	Be responsible for conducting analysis and obtaining reliable and reproducible results.	

6. The course format			
The format of the course	Full-time course		
Type of classes	The total number of hours	The number of hours in 3 semester	The number of hours in 4 semester

Lectures	30	14	16
Practical classes	120	60	60
Self-study	90	46	44

7. Topics and content of the course

Type of classes	Theme	Code of learning outcomes
L-1	Analytical chemistry and chemical analysis. The theory of solutions of strong and weak electrolytes. Basics of the theory of strong electrolytes. Total and active ion concentration, the relationship between them, factor activity. The law of mass action and its application to various types of ionic equilibria in analytical chemistry.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-2	Using the law of mass action to equilibrium in heterogeneous systems and its importance in analytical chemistry.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-3	Applying the law of mass action to acid-base equilibrium and their role in analytical chemistry.	
L-4	Applying the law of mass action to complexation equilibrium and their role in analytical chemistry.	
L-5	Using the law of mass action to equilibrium in homogeneous systems. Redox balance.	
L-6	Methods of separation and concentration of substances. Extraction in analytical chemistry.	
L-7	Chromatographic methods of analysis. The theoretical basis of chromatographic methods. Classification methods. Chromatography in a thin layer of sorbent, sedimentary and paper chromatography. Ion-exchange chromatography. Application analysis of organic and inorganic compounds.	
L-8	Quantitative analysis. Basic principles and methods. Classification. Errors quantitative analysis, classification and causes. Significant numbers. Statistical analysis of the results of chemical analysis. Gravimetric analysis.	
L-9	Titrimetric analysis. Basic concepts. Classification methods. Acid-base titration. Indicators method of acid-base titration. Curves acid-base titration. Selecting indicators for the titration curve. The use of acid-base titration to quantify the chemicals and drugs.	
L-10	Redox titration. Classification methods. Requirements redox reactions. Curves redox titration. Indicators redox titration. The choice of redox indicators. Permanganatometric titration.	
L-11	Iodimetric and iodometric titration. Bromate and bromometric titration. Nitritometric titration. Iodometry, dychromatometry, ceriummetry, iodatometry. The theoretical basis and methods of their application.	
L-12	The precipitation titration. Classification methods. Argentometry. Thiocyanometric and mercurometric titration. Indicators. Application of the chemical and pharmaceutical analysis. Complexometric titration. Complexometry. Titrants and their standardization. Metallochromic indicators. Mercurometric titration. Opportunities methods.	
L-13	Classification of physical methods of analysis. Optical methods of analysis, their classification. Molecular absorption spectroscopy	

	photometry. Refractometry. Polarimetry. Fluorentsence analysis.		
L-14	Electrochemical methods of analysis. Classification. The theoretical basis of methods. Application analysis.		
L-15	Gas and HPLC. Features techniques. Application analysis.		
Type of classes	**Theme**	**Content**	**Code of learning outcomes**
P-1	Fundamentals of Analytical Chemistry. Requirements to analytical reactions.	Terms of security and chemical-analytical laboratory. Basics of qualitative analysis. Qualitative reaction cations and analytical group (K^+, Na^+, NH_4^+), subject to their fulfilment.	
P-2	Applying the law of mass action to acid-base equilibrium and their role in analytical chemistry.	Qualitative reaction cations II (Ag^+, Hg_2^{2+}, Pb^{2+}) and III (Ca^{2+}, Ba^{2+}, Sr^{2+}) analytical group.	
P-3	Using the law of mass action to equilibrium in heterogeneous systems and its importance in analytical chemistry.	Qualitative reaction cations III (Ca^{2+}, Ba^{2+}, Sr^{2+}) analytical group.	
P-4	Systematic analysis of cations mixtures.	Analysis mixture cations I-III analytical groups.	
P-5	The law of mass action and its application to various types of ionic equilibria in analytical chemistry.	Qualitative reaction cations IV analytical group (Al^{3+}, Cr^{3+}, Zn^{2+}, As^{III}, As^{V}, Sn^{II}, Sn^{IV}). Analysis mixture IV analytical group cations.	
P-6	Using the law of mass action to equilibrium in homogeneous systems. Redox balance.	Qualitative reaction cations V analytical group (Mg^{2+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Bi^{3+}, Sb^{II}, Sb^{V}). Analysis mixture V analytical group cations.	
P-7	Using the law of mass action to equilibrium in homogeneous systems. Redox balance.	Qualitative reactions VI analytical group (Cu^{2+}, Co^{2+}, Cd^{2+}, Hg^{2+}, Ni^{2+}). Analysis mixture VI analytical group cations.	
P-8-9	Applying different analytical techniques for complicated samples analysis.	Analysis mixture cations IV-VI analytical group.	
P-10	Theory and practice of anions analysis.	Qualitative reactions of anions I analytical group.	
P-11	Theory and practice of anions analysis.	Qualitative reactions of anions II-III analytical groups.	
P-12	Fractional path of complicated samples analysis.	Analysis mixture of anion-III analytical groups.	
P-13	Methods of separation and concentration of substances.	Analysis mixture of dry salts.	
P-14	Extraction in analytical chemistry.	The use of extraction for identification and separation of metal cations.	
P-15	Chromatographic methods of analysis.	Sedimentary and paper chromatography columns. The separation of mixtures of substances by chromatography in a thin layer of sorbent (TLC).	

P-16	Quantitative analysis. Basic principles and methods. Classification.	Quantitative analysis. Technology weighing on an analytical balance. Defining a mass fraction of magnesium salts, iron (III) by precipitation.	
P-17	Gravimetric analysis.	Gravimetric analysis. Determination of moisture in the compounds $BaCl_2$, KCl, NaCl and pharmaceuticals. Statistical analysis of the results of the analysis.	
P-18	Titrimetric methods of analysis. Basic concepts. Classification methods.	Titrimetric analysis. Measuring utensils, its calibration. Check-capacity volumetric flasks, pipettes, burettes. Titrant their preparation. Calculations in titrimetric analysis.	
P-19	Acid-base titration. Indicators of acid-base titration method.	Titration of strong acids and strong bases vice versa.	
P-20	Curves acid-base titration. Selecting indicators for the titration curve.	Titration polybasic acids, many acid bases, mixtures of acids or bases.	
P-21	The use of acid-base titration to quantify the chemicals and drugs.	Titration of weak acids, alkalis and weak bases strong acids. The use of acid-base titration to quantify the chemicals and drugs.	
P-22	Redox titration. Classification methods. Requirements redox reactions.	Preparation and standardization of potassium permanganate. Determining the mass-volume concentration of H_2O_2, mass fraction of iron salts (II), $H_2C_2O_4 \cdot 2H_2O$, $Na_2C_2O_4$, $NaNO_2$ and others.	
P-23	Iodimetric and iodometric titration. Curves of redox titration. Indicators of redox titration. The choice of redox indicators.	Iodometric determination of oxidants and reducers; preparation and standardization of sodium thiosulfate solution and iodine. Determination of the mass fraction of formaldehyde, iodine, chlorine and others..	
P-24	Bromate and bromometric titration. Nitritometric titration. Iodometry, dichromatometry, ceriummetry, iodatometry	Bromo- and bromatometry. Production of 0.1 m. solution of potassium bromate. Quantitative determination of As_2O_3 , Na_3AsO_3 , in the preparation of sodium salicylate. Nitritometry. Preparation and standardization of titrants. Determination of streptocid mass fraction and others.	
P-25	Complexometric titration. Complexometry. Titrants and their standardization. Metallochromic indicators. Mercurometric titration.	Preparation and standardization of titrants: mercury (II) nitrate Trilon B. Determination of the mass fraction of KCl, NaCl mercurimetric method. Complexometric determining the mass fraction of salts of Ca^{2+}, Mg^{2+}, determine the total water hardness.	
P-26	The precipitation titration. Classification methods. Indicators. Application of the chemical and	Preparation and standardization of titrants: silver nitrate, mercury (I) nitrate. Determination of KCl, KBr, NaCl, NaBr argentometric and mercurometric	

	pharmaceutical analysis.	methods.	
P-27	Classification of physical methods of analysis. Optical methods of analysis, their classification.	Photometric determination of concentrations of potassium permanganate, potassium dichromate, iron (II) and others. in solutions by photocolorimetry.	
P-28	Molecular absorption spectroscopy.	UV spectrophotometry of p-aminobenzoic acid derivatives. Identification and assay. Spectrophotometric determination of concentrations of components in mixtures amidopyrine and caffeine, potassium chromate and potassium permanganate and others.	
P-29	Electrochemical methods of analysis. Classification. The theoretical basis of methods. Application analysis.	Potentiometric determination of individual compounds, the analysis of binary mixtures. Determination of iron (II), a mixture of components in hydrochloric and boric acid salts by potentiometric titration.	
P-30	Gas chromatography. Qualitative and quantitative gas chromatographic analysis.	Alkylnitrites identification with retention parameters. Ethylnitrite determination in water by the absolute calibration and internal standard techniques.	
ISW-1	Master the skills of basic concepts of qualitative chemical analysis. Solve problems of quantitative characteristics of the sensitivity of analytical reactions. Analytical classification cations into groups (sulfide, ammonium phosphate, acid-base). Advantages and disadvantages of each Classification tion.		
ISW-2	Strong and weak electrolytes. The main provisions of strong electrolytes.		
ISW-3	Heterogeneous equilibrium.		
ISW-4	Analysis mixture of cation-III analytical groups.		
ISW-5	Using the law of mass action in analytical chemistry. The main types of equilibria that are used in analytical chemistry. The constant chemical equilibrium. Acid-base balance. The concept of protolytic theory of acids and bases. Hydrolysis.		
ISW-6	Using the law of mass action in analytical chemistry. The main types of equilibria that are used in analytical chemistry. The constant chemical equilibrium. Acid-base balance. The concept of protolytic theory of acids and bases. Hydrolysis.		
ISW-7	The oxidation-reduction and their use in analytical chemistry. Nernst equation. The equilibrium constant. The use of redox reactions in the analysis.		
ISW-8	General characteristics of complex compounds. Equilibrium in solutions of complex compounds. Functional-analytic and analytic-active groups in the organic reagents. Analytical reactions and reagents yaks are used in qualitative analysis.		
ISW-9	Using of organic reagents in analytical chemistry.		
ISW-10	Analysis mixture cations IV-VI analytical group.		
ISW-11	Analytical classification anions. Analytical reactions anio bers.		
ISW-12	Analysis mixture of anion-III analytical groups.		
ISW-13	The analysis of an unknown sample.		

ISW-14	Methods of separation and concentration in analytical chemistry. Extraction.	
ISW-15	Chromatography. Chromatographic methods of analysis. Thin layer chromatography and paper.	
ISW-16	Quantitative analysis. Gravimetric analysis. The main stages of gravimetric determination. Gravimetric and precipitation form. Requirements for these forms. Calculations in gravimetric analysis.	
ISW-17	General titrimetric methods. Fundamentals of quantitative analysis. Quantitative analysis. Ways of expressing the concentration of titrant. Calculations in quantitative analysis. Mathematical processing of results of quantitative analysis.	
ISW-18	Acid-base titration. Titrant method. Primary and secondary standards. Standardization of titrants.	
ISW-19	Acid-base titration. pH indicators. Titration curve. Titration of strong acids, alkalis and vice versa. Titration of weak acids, alkalis and weak bases strong acids. Titration polybasic acids, mixtures of acids and bases. Titration ampholytes.	
ISW-20	Acid-base titration in non-aqueous environments. The use of acid-base titration in the chemical and pharmaceutical analysis.	
ISW-21	Redox titration. Redox indicators. Titration curve. Permanganometry. Application permanganometry to determine the reducing, oxidizing and neutral substances.	
ISW-22	Redox titration. Iodometry. Iodimetry. Iodochlormetry. Application methods for determining reducers, oxidants and some organic compounds.	
ISW-23	Redox titration. Bromatometry. Bromometry. Nitritometry. Application methods for determining reducers, oxidants, phenol derivatives and aromatic amines.	
ISW-24	Redox titration. Ceriummetry. Dihromatometry. Applications in the chemical and pharmaceutical analysis.	
ISW-25	The precipitation titration. Titration curve. Indicators precipitation titration. Argentometry (Mohr and Volhard methods). Mercurometry. Complexometric titration. Complexometry. Complexons. Metallochromic indicators. Application complexonometry analysis cosmetics and drugs.	
ISW-26	Classification of physical methods of analysis. Their advantages and disadvantages of optical analysis techniques. Molecular absorption analysis. The essence of the basic concepts. Laws of light absorption. Rule additivity optical densities. Determination of photometric methods.	
ISW-27	Fluorescent analysis. Emission spectral analysis. Atomic absorption photometry flame.	
ISW-28	IR spectrophotometry. Polarimetry. Nephelometry and turbidimetry.	
ISW-29	Electrochemical methods of analysis. General characteristics. Applications in pharmaceutical analysis. Polarography. Conductometry. Coulometry. Amperometric titration.	
ISW-30	Gas chromatography. Liquid chromatography.	

Learning methods

Explanatory-illustrative, problematic presentation, partially-exploratory.

Studying Analytical Chemistry students use textbooks, lecture notes, methodological guidelines, chemical computer software, molecular models, laboratory devices and glassware necessary for performing experiments.

Methods for organization and accomplishment of studies are:

a) lectures
b) practical classes
c) students' independent study.

The topics of the lecture course cover the problematic issues of the appropriate sections of analytical chemistry.

Practical classes are organized as laboratory classes. These classes include: laboratory studies on detection of specific classes of toxic compounds according to their functional groups, performing specific reactions. Students are recommended to write short-term protocols of laboratory studies, indicating the purpose of the study and the conclusions.

The structure of practical classes includes:

- Discussion and explanation of the most complicated issues of the topic;
- Written test;
- Practical (laboratory) work.
- Filling in a practical lesson protocol.
- Summary of the lesson.

The student's self-study material, which is provided in the subject of the practical lesson at the same time as the classroom work, is evaluated during the ongoing control of the topic in the relevant practical lesson.

Assessment of topics that are presented for self-study and not included in the topics of classroom training, are controlled during the final (credit) classes and exam.

Methodological support. The list and content of educational and methodological support for the study of the discipline "Analytical Chemistry" includes:

- synopsis or extended lesson plan;
- thematic plans of lectures, practical classes, independent work of students;
- tasks for laboratory work and independent work of students;
- questions, tasks, tasks for current and final control of students' knowledge and skills, complex control work, post-certification monitoring of acquired knowledge and skills in the discipline.

8. Verification of learning outcomes

Current control

Types of control: current (routine) and final. ***Form of final control in accordance with the curriculum:*** a credit (3 semester); exam (4 semester).

Control of knowledge and level of students' mastering theoretical material, independent work and the level of acquired skills and practical skills is carried out in practical classes by oral questioning of students; by means of test, graphic and written control; solving situational problems; by evaluating the practical experimental work performed, by assessing the student's ability to correctly interpret the research results obtained, and by evaluating the laboratory protocols drawn up.

At each practical session, the student answers standard questions from the material of the current topic of the lesson, the questions of the lecture course and independent work that relate to the current lesson. The student demonstrates knowledge and skills of practical skills in accordance with the topic of the practical lesson.

It is recommended to apply objective (standardized) kind of control to check theoretical and practical knowledge of students.

The standardized control of the theoretical part includes 13 tasks. Ten of them are the first level test questions. Another three are referred to the tasks of the second level and required a written response (reaction schemes, structure formulas etc.) on the topic of the practical lesson, knowledge of which

is necessary for understanding the current topic, questions of the lecture course and independent work related to the current lesson, demonstrates knowledge and skills of practical skills in accordance with the topic of the practical lesson.

Criteria of assessment of current educational activity:

"Excellent" mark receives a student who correctly, clearly, logically and completely answered the standardized questions of the current topic, including the questions of the lecture course and independent work, gave at least 90% of correct answers to standardized tests, responded to written tasks without any mistake, performed practical work and filled in the protocol.

"Good" mark gets a student who answered the standardized questions of the current topic, lecture course and independent work, gave at least 70% of correct answers to standardized tests, responded to written tasks with some insignificant mistakes, performed practical work and filled in the protocol.

"Satisfactory" mark receives a student who gave with additional questions incomplete answer, could not independently build a clear, logical answer; gave at least 50% of correct answers to standardized tests, responded to written tasks with a lot of mistakes, made mistakes while demonstrating practical skills but performed practical work and made the protocol.

"Unsatisfactory" mark receives a student who cannot answer on question on the current topic with additional questions, cannot construct a logical answer, did not understand the content of the material; gave less than 50% of correct answers to standardized tests, responded to written tasks with gross mistakes or did not give answer, didn't perform practical work and didn't make the protocol.

The total score for the current achievement is the arithmetic mean (CA) of the sum of the scores for the test control and the answers to the questions.

Only those students who completed all types of works provided by syllabus and during study scored points not less than the minimum (3,0), and don't have any undone lectures and practical classes are allowed to put the exam. The standardized form of the exam includes control of theoretical and practical knowledge.

Code of learning outcomes	**Type of classes**	**Verification of learning outcomes**	**Enrollment criteria**
Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-15.	P-1–P-35 ISW-1–ISW-33	Current control: • oral control over the topic of the lesson, standardized questions, knowledge of which is necessary to understand the current topic, questions of the lecture course that relate to the current lesson; • written test control, • solving situational problems, • conducting laboratory tests, • interpretation and evaluation of laboratory test results, • report on the performed	Assessment according to established criteria (see above) with 4-point (national) scale. To enroll in the discipline, it is necessary to confirm the achievement of each learning outcome.

		laboratory work.	
Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-15.	ISW-1–ISW-33	• Oral control in the form of a survey in accordance with the subject of independent work. • Test control on the subject of independent work.	Enrolled / not enrolled
The Final control			
General evaluation system	**The final control** is carried out upon completion of the study of the discipline Analytical Chemistry in the form of a credit (3 semester) and the exam (4 semester). Final control is allowed for students who have completed all types of work required by the curriculum, have completed all training sessions, and have earned points above the minimum level when studying the module. Participation in the work during the semester - 100% on a 200-point scale		
Grades	4-point (national) scale, a multi-scale (200-point) scale, ECTS success scale		
Conditions of admission to the final control	Students who have completed all types of work required by the curriculum, have completed all training sessions, and have earned points above the 120 points when studying the course.		
Form of final control	The form of final control of the success of studies in the study of "Analytical Chemistry" in the 3rd semester is **a semester credit**, and in the 4th semester there is **a semester exam**.		Evaluation criteria
A semester credit	Each class assesses students' knowledge on a 4-point (national) scale. This takes into account all types of work provided by the discipline program. The assessment of analytical chemistry in the 3rd semester is based on the results of the current educational activity and is expressed on a two-point scale "**enrolled**" or "**not enrolled**". The student receives a grade on each topic to further convert the grades into scores on a multi-scale (200-point) scale.		*The maximum number of points - 200.* *The minimum number of points - 120*
An exam	The semester exam is a form of final control of the student's acquisition of theoretical and practical material in analytical chemistry. A student is considered to be admitted to the semester examination in a discipline, if he has attended all the academic curriculum provided by the discipline, completed all types of work stipulated by the curriculum of this discipline, and in his study during the semester he scored less than the minimum score "Satisfactory" (72 points).		*The maximum number of points – 80.* *The minimum number of points - 50*

Examination Regulations

The form of final control is standardized and includes control of theoretical and practical training. *The final control* is a written answer to 5 questions that are in each exam ticket. It takes 2 hours to take the exam. Each written answer question is rated:

5 points - ***"excellent"***

4 points – ***"good"***

3 points **-** ***"satisfactory"***

0 points - ***"unsatisfactory"***

"Excellent" - the student logically, competently, thoroughly, deeply and in detail presented material on all tasks, correctly wrote formulas of substances and mechanism of reactions, showed the schemes of metabolism of substances, substantiated the correct choice of methods of chemical analysis, correctly solved situational problems.

"Good" - the student logically, competently essentially provides incomplete answers to all theoretical questions, with minor errors in chemical formulas, mechanisms of reactions and in calculations and conclusions.

"Satisfactory" - the student answers the theoretical questions without detail, admits inaccuracies and incorrect formulations in the answers, violates the logic of the material, makes mistakes in the chemical formulas of calculations and in the mechanisms of reactions and in situational problems.

"***Unsatisfactory"*** - the student makes significant mistakes, does not cover the essence of the question posed, does not answer the tasks.

The score for the written answer to each question in the exam ticket, where there are 40 MCQ and 8 questions, is converted according to the scale below:

Rating	Scores	The maximum number of points	The minimum number of points
"Excellent"	**80**	**80** (40 MCQ + 5 × 8)	
"Good"	**65**		
"Satisfactorily"	**50**		**50**
"***Unsatisfactory"***	**0**		

The maximum number of points that a student can get for current educational activity during study is 200 points.

The minimum number of points that a student must get to pass the test on the discipline is 120 points.

The analytical chemistry exam score is the sum of the scores for the answer to each of the 5 questions after converting them from a 4-point to a 200-point scale. The maximum score for the exam is **80**. The minimum score is **50.**

Calculating the number of points made on the basis of the student's scores on the traditional 4-point scale during the study of the discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The received value is converted into points by multi-point rate as follows:

The average score for the current activity is converted into a multi-scale scale using the table below:

Recalculation of the average score on "Analytical Chemistry" for the current activity into a multi-scale scale:

4-point rate	**5**	**4.95**	**4.91**	**4.87**	**4.83**	**4.79**	**4.75**	**4.7**	**4.66**	**4.62**	**4.58**	**4.54**	**4.5**
200-point rate	120	119	118	117	116	115	114	113	112	111	110	109	108
4-point rate	**4.45**	**4.41**	**4.37**	**4.33**	**4.29**	**4.25**	**4.2**	**4.16**	**4.12**	**4.08**	**4.04**	**3.99**	**3.95**
200-point rate	107	106	105	104	103	102	101	100	99	98	97	96	95
4-point rate	**3.91**	**3.87**	**3.83**	**3.79**	**3.74**	**3.7**	**3.66**	**3.62**	**3.58**	**3.54**	**3.49**	**3.45**	**3.41**
200-point rate	94	93	92	91	90	**89**	88	87	86	85	84	83	82
4-point rate	**3.37**	**3.33**	**3.29**	**3.25**	**3.2**	**3.16**	**3.12**	**3.08**	**3.04**	**3**	**Less than 3**		
200-point rate	81	80	79	78	77	76	75	74	73	72	Not enough		

The **maximum number of points** that a student can earn for his / her current academic activity upon obtaining a semester credit **in the 3rd semester** is 120 points. The minimum number of points that a student must earn for his / her current academic activity in the 3rd semester (to receive a semester credit) is 72 points (60% of 120 - maximum points).

The **maximum number of points** that a student can earn for his / her current educational activity for the **4th semester** with admission to the semester exam is 120 points.
The minimum number of points, which student can get for current activity and 4th semester for admission to the compilation of semester exam - is 72 points.

Final assessment of the discipline "Analytical Chemistry".

Initially, traditional estimates of current control over the entire course (both semesters) are summarized and calculated the arithmetic mean, to the second decimal place. The calculated arithmetic mean is converted to points on the scale above. And then to these points are added the points obtained for the final control (for the exam). **The sum of these points (for current achievement and for final control) is the final estimate for the course of analytical chemistry.**

The points obtained by students in the final assessment of the discipline are converted into the traditional 4-point scale by the absolute criteria, which are given in the table below:

Score from discipline	Score on 4-point rate
From 170 to 200 points	5
From 140 to 169 points	4

From 139 to the minimum number of points which student must get	3
Below the minimum number of points which student must get	2

To determine the ECTS score, a ranking is made by the number of points earned by the student in the final assessment of the discipline.

Ranking with assignments of grades "A", "B", "C", "D", "E" is made for students of this course, who study in one specialty and have successfully completed the study of the discipline.

The objectivity of the evaluation of students' educational activity is verified by statistical methods (the correlation coefficient between the ECTS grade and the national scale grade).

Conversion of rating point to **ECTS** success **scale** :

ECTS grade	Statistics	Calculations
A	Top 10%	200 - 110 = 90 points 90 b. × 10% = 9 b.
B	Next 25%	90 b. × 25% = 23 b.
C	Next 30%	90 b. × 30% = 27 b.
D	Next 25%	90 b. × 25% = 23 b.
E	Last 10%	90 b. × 10% = 9 b.
F_x	Resubmission	The gap between "folded - not folded" and the minimum tolerance score
F	Compulsory re-training	Less than the minimum tolerance score

Students who have received grades F_X and F ("unsatisfactory") are not included in the list of students who are ranked. Students with an F_X score automatically receive an "E" grade upon transfer. Upon receipt of the F o rating, it is necessary to undergo a second course of study.

Mark written by ECTS can't be converted into traditional scale because the ECTS scale and 4-point scale are independent (do not coincide).

9. Course policies

Attendance policies outline student requirements for participation, whether in a physical classroom or digital learning experience. These policies will generally outline how often a student must attend a course and the consequences of not fulfilling that obligation.

Students are expected to attend all classes and course activities for which they are registered. Any class meeting missed, regardless of cause, reduces the opportunity of learning and may adversely affect a student's achievement in the course. Students are required to attend at least 90% of the class meetings in order to receive credit for the course. An accurate record of attendance will be kept for each course. If a student misses one- third or more of a class session, the student will be counted absent. Three tardiest will count as one absence. Leaving early is the same as being tardy.

If a student misses a class, it is THEIR responsibility to make up the material missed.

Academic Dishonesty. Adherence to academic integrity by students involves:

1. Independent performance of educational tasks, tasks of current and final control of learning outcomes (for persons with special educational needs this requirement is applied taking into account their individual needs and opportunities);

2. References to sources of information in the case of the use of ideas, developments, statements, information; Compliance with copyright and related rights legislation;

3. Providing reliable information about the results of their own (scientific, creative) activities, used research methods and sources of information.

Violations of academic integrity are: academic plagiarism, self-plagiarism, fabrication, falsification, write-off, deception, bribery, biased evaluation.

For violation of academic integrity, students may be involved in re-assessment.

Personal technology policies focus on the permitted use of technology within the classroom.

Per university policy and classroom etiquette; mobile phones, iPods, etc. must be silenced during all classroom and lab lectures. Those not heeding this rule will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, etc., and have been warned may suffer a reduction in their final class grade.

10. Recommended Literature

Compulsory course literature

1. Харитонов Ю. Я. Аналитическая химия (аналитика). В 2-х кн. Кн. 1. Общие теоретические основы. Качественный анализ. М.: Высш.шк., 2001. – 604 с.
2. Харитонов Ю. Я. Аналитическая химия (аналитика). В 2-х кн. Кн. 2. Количественнъій анализ. Физико-химические (инструментальные) методы анализа. – М.: Высш. шк., 2001. – 559 с.
3. Васильєв В. П. Аналитическая химия. В 2 кн. Кн. 1: Титриметрические и гравиметрический методы анализа. - М.: Дрофа, 2003. – 368 с.
4. Васильєв В. П. Аналитическая химия. В 2 кн. Кн. 2: Физико-химические методы анализа. – М.: Дрофа, 2003. – 384 с.
5. Пилипенко А.Т., Пятницкий И.В. Аналитическая химия: В 2 кн. - М.: Химия, 1990. – 846 с.
6. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2015. – Т. 1. – 1128 с.
7. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2014. – Т. 2. – 724 с.
8. Державна Фармакопея України: в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2014. – Т. 3. – 732 с.
9. Аналітична хімія: навчальний посібник / О. М. Гайдукевич, В. В. Болотов, Ю. В. Сич та інш. – Х.: Основа, Вид-во НФАУ, 2000. – 432 с.
10. Практикум з аналітичної хімії: Навч. посіб. для студ. вищ. навч. закл./ В.В. Болотов, Ю.В. Сич, О.М. Свєчнікова, С.В. Колісник, О. Г. Кизим, Т. В. Жукова, М.А. Зареченський, Т.А. Бережна; За заг. ред. В.В. Болотова. – Х.: Вид-во НФАУ; Золоті сторінки, 2003. – 240 с.
11. Аналитическая химия в схемах и таблицах: Справочник для студ. фармац. вузов / В.В. Болотов, Т.В. Жукова, Е.Е. Микитенко, Е. М. Свечникова, Ю.В. Сыч, Т.А. Костина, И.Ю. Петухова, В.П. Мороз ; под общ. ред. В. В. Болотова. – Х.: Изд-во НФАУ; Золотые страницы, 2002. – 172 с.
12. Кількісний аналіз. Титриметричні методи аналізу / Петренко В.В., Стрілець Л.М., Васюк С.О. та ін. – Запоріжжя, 2006. – 215 с.

Auxiliary literature

1. Аналитическая химия. Проблеми и подходы. (Лучший зарубежный учебник) / под ред. Р. Кельнер, Ж.-М. Мерме, М. Отто, Г. М. Видмер; под общ. ред. акад. Ю. А. Золотова. – М: Мир «АСТ», 2004 – Т. 1. – 608 с. – Т. 2. – 728 с.
2. Основы аналитической химии. В 2 кн. кн. 1. Общие вопросы. Методы разделения / Ю. А.

Золотов, Е. Н. Дорохова, В. И. Фадеева и др. Под ред. Ю. А. Золотова. – 2-е изд. – М.: Высш. шк., 1999. – 351 с.
3. Основы аналитической химии. В 2 кн. Кн. 2. Методы химического анализа // Ю. А. Золотов, Е. Н. Дорохова, В. И. Фадеева и др. под ред. Ю. А. Золотова. - 2-е изд. - М.: Высш. шк., 1999. – 494 с.
4. Дорохова Е. Н., Прохорова Г. В. Задачи и вопросы по аналитической химии. – М.: Мир, 2001. – 267 с.
5. Основы аналитической химии. Практическое руководство / В. И. Фадеева, Т. Н. Шеховцова, В. М. Иванов и др.; Под ред. Ю. А. Золотова. – М.: Высш. шк., 2001. – 463 с.
6. Кунце У., Шведт Г. Основы качественного и количественного анализа. - М.: Мир, 1997. – 424 с.
7. Аналитическая химия. Сборник вопросов, упражнений и задач/ В. П. Васильев, Л. А. Кочергина, Т. Д. Орлова; Под ред. В. П. Васильева. – 2-е изд. – М.: Дрофа, 2003. – 320 с.
8. Практикум по аналитической химии / В. П. Васильев, Р. П. Морозова, Л. А. Кочергина; Под ред. В. П. Васильева. М.: Химия, 2000. – 328 с.
9. Коваленко С. І., Васюк С. О., Портна О. О. Комплексиметрія у фармацевтичному аналізі. – Вінниця, НОВА КНИГА, 2008. – 184 с.
10. Аналитическая химия. Химические методы анализа: учеб. пособие / А.И. Жебентяев, А.К. Терносек, И.Е. Галуть. – М. : Новое знание, 2010. – 542 с.
11. Аналитическая химия: в двух томах / Г. Кристиан, пер. с англ. – М. : БИНОМ, Лаборатория знаний, 2009. – 627 с., 616 с.
12. Аналітична хімія: підручник для студентів напряму «Фармація» і «Біотехнологія» ВНЗ / Н. К. Федущак, Ю. І. Бідниченко, С. Ю. Крамаренко, В. О. Калібабчук [та ін.]. – Вінниця : Нова Книга, 2012. – 640 с.

11. Equipment, logistics and software of the discipline / course

Textbooks, computers

12. Additional information

The time and place (specialized, classroom, laboratory, studio, etc.) of the discipline is determined in accordance with the approved schedule. All compulsory and auxiliary literature are available as an e-books.

Syllabus author

Bidnychenko Y.I., PhD, Associated professor _____

Sign

Head of the department

Halkevych Irine, PhD, Associated professor _____

Sign