DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY
Department of Toxicological and Analytical Chemistry

APPROVED
The Acting First Vice-Rector for
scientific and pedagogical work
Assoc. prof. I.I. Solonynko
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CURRICULUM ON THE OPTIONAL DISCIPLINE
CHEMICAL AND TOXICOLOGICAL ANALYSIS

for students of the fourth year of the Pharmacy Faculty

training of specialists of the second (master's) level of higher education
educational qualification «Master of Pharmacy»
education sector 22 «Public Healthcare»
Specialty 226 "Pharmacy, Industrial Pharmacy"

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Head of the department
Assoc. prof. I.Y. Halkevych

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by profile methodical commission
in chemical and pharmaceutical disciplines
Protocol No. 3 from 21.06.2022
Head of the profile methodical commission
Assoc. prof. S.B. Bilous.

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worked out by

Assoc. Prof., Ph.D. Halkevych I.Y.

Sen. Lect., Ph.D. Kramarenko S.Y.

Assoc. Prof., Ph.D. Kostyshyn L.P.

REVIEWER
Associate professor of the Department of General, Bioinorganic, Physical and Colloidal Chemistry
Danylo Halytsky LNMU
Ph.D. Chaban T.I.

INTRODUCTION

Curriculum of the optional discipline **" Chemical and toxicological analysis " is made** in accordance with the draft Standard of Higher Education of Ukraine for the training of specialists of *the second (master's) level*
education sector 22 " Public Healthcare"
specialty 226 " *Pharmacy, Industrial Pharmacy* "
educational program of *Master of Pharmacy*

DESCRIPTION OF THE OPTIONAL DISCIPLINE (ABSTRACT)

The opional discipline "Chemical and Toxicological Analysis" is designed for students of higher educational institutions of the pharmaceutical profile of Ukraine and is an integral part of the state standard of education.

According to the curriculum for the preparation of pharmacists at the educational qualification level "Master", the study of the discipline is carried out in the 4th year (full-time and part-time) which is allocated: 90 hours, the distribution of which is as follows: lectures - 10 hours, laboratory classes -30 hours , independent work - 50 hours.

The curriculam contains the necessary list of knowledge, skills and abilities, taking into account the international requirements for the credit transfer system, international regulations and standards governing the professional activities and training of masters of pharmacy.

Chemical-toxicological analysis is a training course that includes mastering a set of criteria that provide a basis for a correct assessment of the results and conclusions obtained during studies of various objects of biological origin for the presence of toxic substances.

CURRICULUM DESCRIPTION

Types of educational activities according to the curriculum are: a) lectures, b) practical classes, c) independent work of students (ISW).

The structure of the discipline	Number of credits (hours)				Educational level / term	Type of control
	Total credits / hour	Classroom		ISW		
		Lectures (hours)	Practical classes (hours)			
Chemical and toxicological analysis	3,0 credits / 90 hours	10	30	50	IV course (7-8 term)	credit

The subject of study of the opional discipline "Chemical and toxicological analysis" are:

- organizational structure and staff of laboratories of chemical and toxicological analysis;
- setting a task for research;
- the choice of selection method when conducting research;
- use of different methods for sample cleaning;
- detection of toxic substances in biological objects;
- quantification of toxic substances in biological objects;
- interpretation of research results on the presence of drugs and other potentially toxic compounds in tissues and body fluids, so that they can be protected in court;
- tools and their calibration;
- rules for storage of biological samples.

Interdisciplinary links:

Chemical and toxicological analysis as a discipline:

a) is based on knowledge of analytical chemistry, biological chemistry, physiology, organic and inorganic chemistry.

1. The purpose and objectives of the discipline

1.1. **The purpose of teaching the opional course "Chemical and toxicological analysis"** is to provide students with theoretical knowledge and practical skills of the organization of work of chemical-analytical laboratories; conducting chemical and toxicological studies and interpretation of the obtained results.

1.2. **The main objectives of the study of the discipline of choice "Chemical and toxicological analysis" are:** to teach students the features of chemical and toxicological laboratories, planning and research of biological material for the presence of toxicants, development of new and improvement of existing methods of isolation of toxic substances from relevant facilities, development of effective methods for cleaning extracts obtained from chemical and toxicological analysis , to detect and quantify toxic substances in them.

1.3. Competences and learning outcomes, the formation of which is facilitated by the discipline (relationship with the normative content of training of higher education seekers, formulated in terms of learning outcomes in the Standard of Higher Education).

According to the requirements of the Standard, the opional discipline "Chemical and toxicological analysis" contributes to the acquisition by students of competencies:

integral:

- ability to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity with the application of theoretical principles of toxicology, reasonably substantiate research results and unambiguously communicate their conclusions and knowledge to professional and non-professional audience;

general:

• GC 2. Ability to apply knowledge in practical situations

• GC 3. Efforts to preserve the environment.

• GC 4. Ability to abstract thinking, analysis and synthesis, ability to learn and be modernly trained

• GC 6. Knowledge and understanding of the subject area and understanding of professional activity.

• GC 7. Ability to adapt and act in a new situation.

• GC 11. The ability to evaluate and ensure the quality of performed works

• GC 12.Ability to conduct research at the appropriate level.

special (professional, subject):

• PC 6. The ability to identify drugs, xenobiotics, toxins and their metabolites in biological fluids and body tissues, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication.

• PC 19. The ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy, to determine sampling methods for medicinal product control and to carry out their standardization in accordance with current requirements, to prevent the distribution of falsified medicinal products.

• PC 20. Ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, pharmacotechnological and pharmaco-organoleptic control methods.Detailing of competencies according to NQF descriptors in the form of "Competence Matrix"

Competence Matrix

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
1	**2**	**3**	**4**	**5**	**6**
Integral competence					
Ability to solve typical and complex specialized problems and practical problems in professional activities in the field of health care, or in the learning process, which involves research and / or innovation and is characterized by complexity and uncertainty of conditions and requirements.					
General competencies					
1	GC 2. Ability to apply knowledge in practical situations	Have specialized conceptual knowledge acquired in the process of education	To be able to solve complex tasks and problems that arise in professional activity.	Clear and unambiguous presentation of one's own conclusions, knowledge and explanations, which justify them to specialists and non-specialists.	Be responsible for making decisions in difficult conditions
2	GC 3. The desire to preserve the environment.	To know the problems of preserving the environment and the ways of its preservation	To be able to form requirements for oneself and others regarding the preservation of the environment	Make proposals to relevant bodies and institutions regarding measures to preserve and protect the environment	To be responsible for the implementation of environmental protection measures within the framework of one's competence
3	GC 4. The ability to abstract thinking, analysis and synthesis, the ability to learn and be modernly educated	To know methods of analysis, synthesis and further modern education	Be able to analyze information, make informed decisions, be able to acquire modern knowledge	Establish appropriate connections to achieve goals.	To be responsible for the timely acquisition of modern knowledge.
4	GC 6. Knowledge and understanding of the subject area and understanding of professional activity.	To have deep knowledge of the structure of professional activity	To be able to carry out professional activities that require updating and integration of knowledge	The ability to effectively form a communication strategy in professional activities	To be responsible for professional development, the ability for further professional training with a high level of autonomy

5	GC 7. Ability to adapt and act in a new situation.	Know the methods of implementing knowledge in solving practical tasks	To be able to use professional knowledge for adaptation and actions in a new situation	To establish connections with subjects of practical activity	To be responsible for the quality of the performance of professional tasks in a new situation
6	GC 11. The ability to evaluate and ensure the quality of performed works	Know the methods of evaluating performance quality indicators	Be able to ensure quality performance of work	Establish relationships to ensure quality performance of work	To be responsible for quality performance of works
7	GC 12. Ability to conduct research at an appropriate level.	Know the methods of conducting research and evaluating their results	Be able to plan and conduct research, evaluate their results	Liaise to ensure research is carried out at the appropriate level	Be responsible for planning and conducting research at the appropriate level
Special (professional, subject) competencies					
1.	PC 6. The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication.	Know the methods of isolation, identification and quantification of medicines, xenobiotics, toxins and their metabolites in biological fluids and body tissues.	Be able to draw up a plan of chemical and toxicological analysis. To be able to isolate, identify and quantify drugs, xenobiotics, toxins and their metabolites.	Establish connections for selection of optimal methods of isolation, identification and quantification of drugs, xenobiotics, toxins and their metabolites. Reasonably evaluate and interpret the results of chemical, physico-chemical and physical methods in chemical-toxicological analysis	Be responsible for making a decision regarding the evaluation of the results of chemical and physicochemical methods for the detection and quantification of substances. To be responsible for the interpretation of the obtained results and the correctness and evidentiality of the conducted research.
2	PC 19. The ability to organize and carry out quality control of medicinal products	To know the order of chemical and toxicological studies for the	To be able to apply chemical and instrumental methods of analysis, to	Reasonably evaluate and interpret the results of chemical,	Be responsible for making a decision regarding the evaluation of the results of

	in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy, to determine sampling methods for the control of medicinal products and to carry out their standardization in accordance with current requirements, to prevent the distribution of falsified medicinal products.	purpose of diagnosing acute poisoning, drug and alcohol intoxication.	conduct chemical and toxicological studies. Be able to apply chemical and instrumental methods of analysis, conduct quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy. To be able to determine the methods of sampling for the control of medicinal products and carry out their standardization in accordance with the current requirements and to prevent the distribution of falsified medicinal products.	physico-chemical and physical methods in the implementation of quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy. Use sampling connections to control medicinal products and standardize them in accordance with current requirements, prevent the distribution of falsified medicinal products.	chemical and physicochemical methods for the detection and quantification of substances. To be responsible for the interpretation of the obtained results and the correctness and evidentiality of the conducted research.
3	PC 20. Ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological,	Know the main methods of quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy, determine	Be able to select conditions for quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical,	Select the connections between the properties of the researched objects and the features of the analysis method for the development of methods of identification, determination of purity and quantification of	Be responsible for making a decision regarding the evaluation of the results of chemical and physicochemical methods for the detection and quantification of substances. To be responsible for the interpretation of the obtained

	microbiological, pharmacotechnological and pharmaco-organoleptic control methods.	methods of sampling for medicinal product control and carry out their standardization in accordance with current requirements, prevent the distribution of falsified medicinal products.	physico-chemical, biological, microbiological, pharmacotechnological and pharmaco-organoleptic control methods.	medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances	results and the correctness and evidentiality of the conducted research.

Learning outcomes:

Integrative final program learning outcomes, the formation of which is facilitated by the discipline "Chemica and toxicological analysis".

- PLO 1 To carry out professional activities in social interaction based on humanistic and ethical principles; to identify future professional activity as socially significant for human health.
- PLO 2 Apply knowledge from general and specialized disciplines in professional activities.
- PLO 3 To comply with the norms of the sanitary and hygienic regime and the requirements of safety equipment when carrying out professional activities.
- PLO 4 Demonstrate the ability to independently search, analyze and synthesize information from various sources and use these results to solve typical and complex specialized tasks of professional activity.
- PLO 6 Argue information for decision-making, bear responsibility for them in standard and non-standard professional situations; adhere to the principles of deontology and ethics in professional activity. oral communication skills in a foreign language, analyzing specialized texts and translating foreign language information sources.
- PLO 7 To perform professional activities using creative methods and approaches.
- PLO 8 To carry out professional communication in the state language, to use
- PLO 11 Use methods of evaluating indicators of the quality of activity;
- identify reserves for increasing labor efficiency.
- PLO 12 Analyze information obtained as a result of scientific research, generalize, systematize and use it in professional activities.
- PLO 13 To carry out sanitary and educational work in professional activities in the event of outbreaks of infectious, viral and parasitic diseases.
- PLO 14 Determine the advantages and disadvantages of drugs of various pharmacological groups, taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic and pharmacodynamic features.
- Recommend to consumers over-the-counter medicines and other products of the pharmacy assortment with the provision of advisory assistance and pharmaceutical care.
- PLO 15 Provide pre-medical assistance to patients in emergency situations and victims in extreme situations.
- PLO 16 Determine the influence of factors that affect the processes of absorption, distribution, deposition, metabolism and excretion of the medicinal product and are caused by the condition, features of the human body and physico-chemical properties of medicinal products.
- PLO 17 Use the data of clinical, laboratory and instrumental studies to monitor the effectiveness and safety of the use of medicinal products.

- PLO 18 Choose biological objects of analysis, determine xenobiotics and their metabolites in biological environments and evaluate the results obtained taking into account their distribution in the body.
- PLO 19 Predict and determine the influence of environmental factors on the quality of medicines and consumer characteristics of other products of the pharmacy assortment during their storage.
- PLO 20 To carry out a complex of organizational and management measures to provide the population and health care institutions with medicines and other products of the pharmacy assortment. Carry out all types of accounting in pharmacies, administrative records, product analysis processes.
- PLO 21 Calculate the main economic indicators of pharmacy establishments, as well as taxes and fees. Form all types of prices (wholesale, purchase and retail) for medicinal products and other products of the pharmacy assortment.
- PLO 22 Manage pharmaceutical organizations and determine its effectiveness using management functions. Make management decisions based on the developed leadership and communication skills of pharmaceutical personnel regarding the strategic planning of enterprise activities.
- PLO 23 To take into account data on socio-economic processes in society for the pharmaceutical supply of the population, to determine the effectiveness and availability of pharmaceutical care in terms of medical insurance and reimbursement of the cost of drugs.
- PLO 24 Plan and implement professional activities on the basis of normative legal acts of Ukraine and recommendations of proper pharmaceutical practices.
- PLO 25 To contribute to the preservation of health, in particular the prevention of diseases, the rational prescription and use of medicinal products. To faithfully fulfill one's professional duties, to comply with the legislation on the promotion and advertising of medicinal products. Possess psychological communication skills to achieve trust and mutual understanding with colleagues, doctors, patients, consumers.

- PLO 26 Choose a rational technology, manufacture medicinal products in various dosage forms according to the prescriptions of doctors and orders of medical institutions, prepare them for release. Perform technological operations: weigh, measure, dose various medicinal products by weight, volume, etc. Develop and draw up technological documentation for the manufacture of medicinal products in pharmacies.
- PLO 27 To substantiate the technology and organize the production of medicinal products at pharmaceutical enterprises and draw up technological documentation for the production of medicinal products at pharmaceutical enterprises.
- PLO 28 Organize and carry out rational procurement of medicinal plant raw materials. Develop and implement measures for the protection, reproduction and rational use of wild species of medicinal plants.
- PLO 29 To ensure competitive positions and effective development of pharmaceutical organizations on the basis of conducted research on all elements of the marketing complex.
- PLO 30 Ensure quality control of medicinal products and document its results. To carry out quality risk management at all stages of the life cycle of medicinal products.
- PLO 31 Carry out all types of quality control of medicinal products; draw up quality certificates of a series of medicinal products and a certificate of analysis, taking into account the requirements of current regulatory documents, the State Pharmacopoeia of Ukraine and the results of quality control. Develop specifications and quality control methods in accordance with the requirements of the current State Pharmacopoeia of Ukraine.
- PLO 32 Determine the main organoleptic, physical, chemical, physicochemical and pharmacotechnological indicators of medicinal products, justify and choose methods of their standardization, carry out statistical processing of the results in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

Learning outcomes for the opional discipline "Chemical and toxicological analysis":

To know:

- subject and tasks of chemical and toxicological analysis;
- organization of chemical and toxicological analysis;
- methods of qualitative and quantitative analysis;
- methods of sample cleaning;
- methods of isolating substances from biological samples;
- main validation characteristics of analysis methods;
- features of interpretation of research results.

To be able to:

- work with regulations on chemical and toxicological analysis;
- take and prepare samples for analysis;
- use standard compounds in the development of methods of analysis;
- to carry out validation of analytical methods.

2. Information volume of the discipline of choice

3 ECTS credits / 90 hours are allocated for the study of the academic discipline.

Topic 1. Subject and tasks of chemical and toxicological analysis.

The main tasks facing chemical and toxicological analysis. The main legislation governing its implementation. Organizational structure of chemical and toxicological laboratories in Ukraine. Basic concepts of poisoning and poisons. Objects of chemical and toxicological analysis.

Topic 2. Methods of isolation of substances from objects of biological origin.

Selection methods, their review and stages. Factors to consider when choosing a method of isolation: physicochemical properties of substances, method of identification and quantification, and others. Determining the cause of unsatisfactory allocation results.

Topic 3. Methods of purification of extracts from biological material and concentration of substances.

Methods of protein denaturation, the process of their implementation and main characteristics. Using freezing. Liquid-liquid and solid-phase extractions, features of their carrying out and calculations. Classification of sorption and chromatographic methods, their use for cleaning extracts. Characteristics of distillation methods and their use. Review of other methods.

Topic 4. Methods of preliminary detection of substances.

Preliminary tests and screening, their purposes and use in chemical and toxicological analysis. Classification of immunochemical methods, their principle and characteristics. Method of chromatography in thin layers of sorbent, its use in rapid analysis. Automated systems for the diagnosis of poisoning by certain substances.

Topic 5 The use of gas chromatography for the detection and quantification of substances.

The structure of the gas chromatograph. The main sorbents used to separate substances. Principles of identification and quantification of compounds. The main groups of substances that can be detected and quantified by gas chromatography.

Topic 6. The use of high performance liquid chromatography (HPLC) and electrophoretic methods for the detection and quantification of substances.

The structure of the chrome agraph for HPLC. Basic sorbents and solvent systems used for separation of substances. Principles of identification and quantification of compounds. The main

groups of substances that can be detected and quantified by HPLC. The basic principles underlying the separation of electrophoretic methods. Use of electrophoresis on paper, gel electrophoresis, capillary electrophoresis for identification of substances

Topic 7. The use of atomic emission and atomic adsorption analysis for the detection and quantitative metals.

Use of UV spectrophotometry in chemical toxicological analysis.

Basic principles and use of atomic emission and atomic adsorption methods in chemical and toxicological analysis. Structure of devices. Principles of identification and quantification of substances by UV spectrophotometry.

3. The structure of the discipline

Topic	Number of hours		
	Lectures	Practical classes	ISW
Topic 1. Subject and tasks of chemical and toxicological analysis.	2	4	8
Topic 2. Methods of isolation of substances from objects of biological origin.	2	2	8
Topic 3 Methods of purification of extracts from biological material and concentration of substances.	2	2	8
Topic 4. Methods of preliminary detection of substances.	1	8	8
Topic 5. The use of gas chromatography for the detection and quantification of substances.	1	4	8
Topic 6. The use of high performance liquid chromatography (HPLC) and electrophoretic methods for the detection and quantification of substances.	2	4	4
Topic 7. The use of atomic emission and atomic adsorption analysis for the detection and quantitative metals. Use of UV spectrophotometry in chemical toxicological analysis.		6	6
Total	10	30	50

4. Thematic plan of lectures

№	Topic	Number of hours
1.	Subject and tasks of chemical and toxicological analysis.	2
2.	Basic legislation governing chemical and toxicological analysis.	2
3.	Organizational structure of chemical and toxicological laboratories in Ukraine. Basic concepts of poisoning and poisons. Objects of chemical and toxicological analysis.	2
4.	Methods of isolation of the main groups of poisons, depending on their physicochemical properties: distillation, mineralization, infusion with insulating polar	2

	and organic liquids.	
5.	Methods of purification of extracts from biological material and concentration of substances. Liquid-liquid and solid-phase extractions, features of their carrying out and calculations. Classification of sorption and chromatographic methods, their use for cleaning extracts.	2
	Total	**10**

5. Thematic plan of practical classes

№	Topic	Number of hours
1.	Rules of work in the laboratory. Organizational structure of the laboratory for chemical and toxicological analysis. The main tasks of chemical and toxicological analysis. The concept of poisoning and poison and their types. Toxicological characteristics of poisons.	2
2.	Laws of Ukraine on which chemical and toxicological analysis is based. The main stages of chemical and toxicological research. The concept of the plan of chemical and toxicological analysis and its compilation.	2
3.	Features of analysis of substances in biological objects. Isolation of substances from biological material, its main tasks and stages. Approaches to the selection of the method depending on the nature of the substances, research methods and the object of research.	2
4.	Cleaning as one of the stages of selection. The main types of purification used in chemical and toxicological analysis. Their mechanism, advantages and disadvantages.	2
5.	Preliminary tests in chemical and toxicological analysis. The concept of screening. The main differences between screening and previous samples. Tasks that are solved through screening and preliminary tests. Review of methods used for preliminary detection of substances.	4
6.	Enzyme-linked immunosorbent assay and immunochromatographic analysis, their principle of operation and procedure. Errors of immunological methods.	2
7.	Use of chromatography in thin layers of sorbent to identify substances in extracts from biological material. The principle and procedure for making definitions.	2
8.	Use of gas chromatography for detection and quantification of substances. The structure of the gas chromatograph. The order of the study. Methods of qualitative and quantitative analysis.	4
9.	Using the method of high performance liquid chromatography to identify and quantify substances. The principle of selection of the column and solvent system. The order of research. Methods of qualitative and quantitative analysis.	2
10.	Paper electrophoresis and gel electrophoresis. Use in chemical and toxicological analysis. The structure of the device for capillary electrophoresis and the procedure for research.	2
11.	Principles of operation of devices for atomic emission and atomic adsorption	4

	spectrophotometry. The procedure for detection and quantification of metals by these methods.	
12.	Identification and quantification of substances by UV spectrophotometry.	2
	Total	**30**

6. Thematic plan of individual work of students

№	Topic	Number of hours	Type of control
1.	Subject and tasks of chemical and toxicological analysis. Structure of laboratories for chemical and toxicological analysis. Rules for obtaining and storing samples. Laboratory equipment, its selection and qualification. Law of Ukraine "On Forensic Examination", Instruction on forensic medical examination and the Code of Criminal Procedure of Ukraine.	8	Current control in practical classes
2.	Chemical and toxicological analysis plan. Structure, procedure for drafting and making changes.	**8**	
3.	Classification of substances depending on the method of their isolation from biological material. The most common methods of isolation of substances from objects of biological origin.	**8**	
4.	Methods of purification of extracts from biological material and concentration of substances. Methods of preliminary detection of substances.	**8**	
5.	Retention parameters in gas chromatography and HPLC. Factors that affect them. Use for substance identification. Mass spectrometry in chemical toxicological analysis. The principle of the method. Types of mass spectrometric detectors used in gas chromatography and HPLC, the principle of their operation. Identification of substances by mass spectra. Bases of mass spectra, use in chemical and toxicological analysis.	**8**	
6.	Basic methods of quantitative determination of substances in gas chromatography and HPLC. The principle of method selection, the procedure for determining and establishing its metrological characteristics. Rules for checking the reproducibility of quantitative methods.	4	
7.	Instrumental methods for identification and quantification of metals. Spectrophotometry in the ultraviolet part of the spectrum and in the infrared part of the spectrum. Use in chemical and toxicological analysis.	**4**	

8.	Features of validation of methods in chemical and toxicological analysis.	**2**	
	Total	**50**	

7. Individual tasks ***for students full-time students are not provided.***

Tasks for individual work

1. Plan of chemical and toxicological analysis. On the basis of what data is the plan for the study of biological material on an unknown poison in a chemical-toxicological study?
2. Isolation of acids, alkalis and salts from the objects of analysis.
3. Isolation of inorganic acids from biological material.
4. Isolation of volatile substances from biological material. What are the main methods used for this.
5. Isolation of metals and "metallic" poisons from biological material. Mineralization methods.
6. Isolation of substances by water acidified with organic and inorganic acids.
7. The main methods used to isolate pesticides from biological objects.
8. Modern universal methods of separation of organic substances.
9. How to detect substances by enzyme-linked immunosorbent assay.
10. Detection of substances by immuno-chromatography.
11. On the basis of what data is the detection and determination of organic matter by gas chromatography?
12. On the basis of what data is the detection and determination of organic matter by HPLC?
13. What electrochemical methods can be used to identify metals? Give the order of the study.
14. On the basis of which data is the detection and determination of substances by atomic emission spectroscopy?
15. On the basis of what data is the detection and determination of substances by atomic adsorption spectroscopy?
16. On the basis of what data is the detection and determination of organic matter by electrophoresis?
17. On the basis of what data is the detection and determination of organic matter by UV spectrophotometry?

8. Teaching methods

In the process of studying the discipline "Chemical-toxicological analysis" the following teaching methods are used:

- explanatory-illustrative - (verbal and visual - lectures, theoretical part of the seminar);
- partial search method - preparation for a seminar, testing, control of independent work;
- research method - performing experimental work.

Preference is given to active and interactive methods and multimedia learning (multimedia lectures, educational films).

9. Control methods

Assimilation of the topic is controlled in practical classes in accordance with specific objectives, assimilation of the content module (intermediate control) - in the final lesson. The following means of control of level of preparation of students are applied:

- oral examination and written assignments;
- solving situational problems;
- testing the ability to interpret and evaluate the results of various methods of identification and quantification of substances, control of practical skills.

Forms of current control:

theoretical knowledge - individual surveys, interviews;

practical skills and abilities - solving typical and situational problems and control of practical actions.

Final control is carried out on the basis of control of theoretical knowledge, practical skills and abilities.

At each lesson, the level of students' knowledge is assessed on a 4-point scale ("5", "4", "3", "2") in accordance with the criteria for assessing the current activities of the student. The obtained scores are converted into appropriate points.

10. The current control is carried out during the training sessions and aims to check the assimilation of educational material by students. Forms of assessment of current educational activities are standardized and include control of theoretical and practical training.

10.1 Evaluation of current educational activities. At each practical lesson, the student answers 10 tests, 5 questions on the topic of the practical lesson, knowledge of which is necessary to understand the current topic, the issues 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 practical training.

Evaluation criteria

I. Current control. At each lesson, the level of students' knowledge is assessed on a 4-point (national) scale. This takes into account all types of work provided by the discipline program. The student receives a grade from each topic for further conversion of grades into points on a multi-point (200-point) scale.

"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 can not answer on question on the current topic with additional questions, can not 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.

At each practical lesson, the student's knowledge is assessed on a four-point system ("5", "4", "3", "2") according to the criteria for assessing the current activities of the student.

11. The form of final control of learning success: credit.

Semester credit is a form of final control, which consists in assessing the student's mastery of educational material solely on the basis of the results of certain types of work in practical, seminar or laboratory classes.

12. Scheme of accrual and distribution of points received by students:

The maximum number of points that a student can receive for the current activity is 200 points. The minimum number of points that a student can score for the current activity for the test is 120 points.

The calculation of the number of points is based on the grades obtained by the student on the traditional scale during the study of the discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The value obtained is converted into points on a multi-point scale as follows: $x = CA \times 120/5$

Recalculation of the average score on "Chemical and toxicological analysis " for the current activity into a multi-scale scale:

4-points scale	**5**	**4.97**	**4.95**	**4.92**	**4.9**	**4.87**	**4.85**	**4.82**	**4.8**	**4.77**	**4.75**	**4.72**	**4.7**
200-points scale	200	199	198	197	196	195	194	193	192	119	190	189	188
4-points scale	**4.67**	**4.65**	**4.62**	**4.6**	**4.57**	**4.52**	**4.5**	**4.47**	**4.45**	**4.42**	**4.4**	**4.37**	**4.35**
200-points scale	187	186	185	184	183	181	180	179	178	177	176	175	174
4-points scale	**4.32**	**4.3**	**4.27**	**4.24**	**4.22**	**4.19**	**4.17**	**4.14**	**4.12**	**4.09**	**4.07**	**4.04**	**4.02**
200-points scale	173	172	171	170	**169**	168	167	166	165	164	163	162	161
4-points scale	**3.99**	**3.97**	**3.94**	**3.92**	**3.89**	**3.87**	**3.84**	**3.82**	**3.79**	**3.77**	**3.74**	**3.72**	**3.7**
200-points scale	160	159	158	17	**156**	155	154	153	152	151	150	149	148
4-points scale	**3.67**	**3.65**	**3.62**	**3.57**	**3.55**	**3.52**	**3.5**	**3.47**	**3.45**	**3.42**	**3.4**	**3.37**	**3.35**
200-points scale	147	146	145	144	143	142	141	140	139	138	137	136	135
4-points scale	3.32	3.3	3.27	3.25	3.22	3.2	3.17	3.15	3.12	3.1	3.07	3.02	3
200-points scale	133	132	131	130	129	128	127	126	125	124	123	121	120
4-points scale	**Less than 3**												
200-points scale	Not enough												

The student's independent work is assessed during the current control of the topic in the relevant classroom. Assessment of topics that are submitted for self-study and are not included in the topics of classroom training, are controlled during the final tests.

The form of final control of training when studying the course "Chemical-toxicological analysis" - is a test, which is given to a student who has performed all types of work provided by the curriculum, completed all classes and scored no less than the minimum.

13. Methodical support

The list and content of educational and methodological support for the study of the discipline of choice "Chemical and toxicological analysis" includes:

- Multimedia texts of lectures
- Computers
- A set of situational tasks for classes.
- Recommended Books.

14. Recommended Literature

Basic

1. Bidnychenko Y. Toxicological chemistry: Handbook for students. - Lviv, 2009. - 175 p.
2. Bondar VS Toxicological chemistry. Schemes and tables: Handbook for students of higher school / B.C. Bondar, S.A. Karpushina - Kharkiv: NUPh: Golden Pages, 2009. - 120 p.
3. Hodgson E. A Textbook of Modern Toxicology, 4th Edition - John Wiley & Sons, 2004. - 672 p.
4. Belousov Yu.B., Gurevich KG Clinical pharmacokinetics. Drug dosing practice. - M .: Litterra, 2005. - 288 p.
5. Derimedved LV Interaction of drugs and effectiveness of pharmacotherapy / L.V. Derimedved, IM Peppers [etc.]. - H.: Megapolis, 2001. - 784 s.
6. Medical interaction and drug safety: a manual / L.L. Davtyan, GV Zagoriy, Yu.V. Voronenko and others. - K .: PE "Prodigal MI", 2011. - 744 p.

Auxiliary

1. Handbook of Toxicology. 2 ed. / Edited by Derelanko M.J., Hollinger_M.A. - N.W.: CRC Press LLC, 2002 – 1380 p.
2. Poisoning and Drug Overdose. Fifth Edition / Edited by Kent R. Olson. - San Francisco: The McGraw-Hill Companies, 2007. – 1132 p.
3. Randall C. Baselt. Disposition of Toxic Drugs and Chemicals in Man. – California, Foster City; Chemical Toxicology Institute, 2000. – 920 p.
4. Cronin M.T.D., Madden J.C., Enoch S.J., Roberts D.W. Chemical Toxicity Prediciton: The Royal Society of Chemistry, UK, 2013. — 204 p.
5. Handbook of Toxicology. 2 ed. / Edited by Derelanko M.J., Hollinger_M.A. - N.W.: CRC Press LLC, 2002 – 1380 p.
6. Poisoning and Drug Overdose. Fifth Edition / Edited by Kent R. Olson. - San Francisco: The McGraw-Hill Companies, 2007. – 1132 p.
7. Randall C. Baselt. Disposition of Toxic Drugs and Chemicals in Man. – California, Foster City; Chemical Toxicology Institute, 2000. – 920 p.
8. Flanagan R.J., Taylor A.A., Watson I.D., Whelpton R. Fundamentals of Analytical Toxicology. – New York: WileyBlackwell, 2008. – 544 p.
9. Moffat A.C., Osselton M.D., Widdop B. Clarke's analysis of drugs and poisons in pharmaceuticals, body fluids and postmortem material. – London: Pharmaceutical Press, 2011. – 2609 p.
10. Flanagan R.J. Developing an Analytical Toxicology Service: Principles and Guidance / Flanagan R.J. // Toxicological Reviews. – 2004. – Vol. 23, №4. – P. 251-263.

15. Information resources

https://new.meduniv.lviv.ua/uploads/repository/kaf/kaf_toxchemistry/01.%D0%9D%D0%B0%D0%B2%D1%87%D0%B0%D0%BB%D1%8C%D0%BD%D0%BE_%D0%BE%D1%80%D0%B3%D0%B0%D0%BD%D1%96%D0%B7%D0%B0%D1%86%D1%96%D0%B9%D0%BD%D0%B0_%D1%80%D0%BE%D0%B1%D0%BE%D1%82%D0%B0/02.%D0%A2%D0%BE%D0%BA%D1%81%D0%B8%D0%BA%D0%BE%D0%BB%D0%BE%D0%B3%D1%96%D1%87%D0%BD%D0%B0_%D1%82%D0%B0_%D1%81%D1%83%D0%B4%D0%BE%D0%B2%D0%B0_%D1%85%D1%96%D0%BC%D1%96%D1%8F/Metodychni_rekomendatsii_chastyna_1.pdf