

National Pirogov Memorial Medical University, Vinnytsya

“APPROVE ”

Vice -Rector of higher education institution
for Research, Education and Teaching



professor of HEI

Oksana SEREBRENNIKOVA

“2” September 2022 year

“AGREED”

Head of the Pharmaceutical Chemistry
Department



Assoc. prof. of HEI

Tetyana YUSHCHENKO

“1” September 2022 year

SYLLABUS
of academic discipline
Analytical chemistry

Specialty	226 Pharmacy, Industrial Pharmacy
Educational level	the second (master`s) level
Educational programme	EPP “Pharmacy”, 2022
Academic year	2022-2023
Department	Pharmaceutical Chemistry Department
Lecturer	Kosareva A.E., Senior teacher
Contact information	<i>pharmchem@vnmua.edu.ua,</i> <i>Pirogov str., 56, tel. 55-39-54</i>
Syllabus compiler	Kosareva A.E., Senior teacher

1. Status and structure of the discipline

Discipline status	Compulsory
Discipline code in EPP/ discipline place in EPP	CC 19//discipline of general training
Course / semester	2d year (III, IV semester)
The amount of discipline (the total number of hours / number of credits ECTS)	225 hours / 7, 5 credits ECTS
Number of content modules	8 modules
The structure of the discipline	Lectures - 28 hours Practical classes - 118 hours Independent work - 79 hours
Language of study	English
Form of study	Full - time (<i>or remote by order</i>)

2. Description of the discipline

Short annotation of the course, relevance. The discipline "Analytical Chemistry" belongs to the obligatory disciplines of the cycle of professionally-oriented training of specialists in the specialty 226 Pharmacy, industrial pharmacy. The study of the discipline is aimed at gaining knowledge of the theoretical foundations of chemical analysis and modern physical-chemical methods of analysis, the formation of practical skills and abilities to conduct qualitative and quantitative analysis of substances and their mixtures by chemical and instrumental methods. Analytical chemistry as a discipline is focused on obtaining the knowledge necessary for the successful mastering of disciplines of professional training and involves the formation of skills to apply the acquired knowledge in professional activities.

Prerequisites. Basic knowledge of the following disciplines is required for successful learning of the discipline "Analytical Chemistry" and for achievement of program results: "General and Inorganic Chemistry", "Higher Mathematics and Statistics", "Biological Physics and Physical Methods of Analysis".

The purpose of the course and its significance for professional activity. The purpose of the discipline "Analytical Chemistry" is providing students with the necessary theoretical knowledge about chemical and instrumental methods of analysis, as well as the formation of important practical skills and abilities for conducting of qualitative and quantitative analysis of substances and mixtures by chemical and instrumental methods.

Mastering the discipline will allow students to acquire, in addition to integral, the following competencies:

General (GC): GC 2, GC 3, GC 4, GC 6, GC 7, GC 8, GC 9, GC 10, GC 11, GC 12.

Special (professional): PC 19.

Postrequisites. The knowledge and skills acquired during the study of the discipline lay the foundations for successful mastering of the such disciplines of professional training as "Pharmaceutical Chemistry", "Drug Technology", "Toxicological and Forensic Chemistry", "Pharmacognosy", "Standardization of Medicines", "Physico-Chemical analysis in the development of drugs" and contribute to the formation of practical skills and abilities to conduct qualitative and quantitative analysis of substances needed in professional activities.

3. Learning outcomes.

As a result of studying the discipline "Analytical Chemistry" the student must:

Know:

- basic concepts and laws underlying analytical chemistry;
- the main stages of development of analytical chemistry, its current state;
- the main provisions of the theory of ionic equilibria in relation to acid-base, redox, precipitation and compleximetric reactions;

- methods and ways of performing qualitative analysis;
- methods, techniques and methods of performing chemical and physico-chemical analysis to establish the qualitative composition and quantitative definitions;
- methods for detecting cations and anions;
- methods of separation of substances (chemical, chromatographic, extraction);
- basics of mathematical statistics regarding the assessment of the correctness and reproducibility of the results of quantitative analysis;
- safety rules when working in a chemical laboratory;
- the role and importance of methods of analytical chemistry in pharmacy, in the practical activities of the pharmacist;
- the main literature sources, reference literature on analytical chemistry.

Be able to:

- use measuring utensils, analytical scales; have the technique to perform basic analytical operations in the qualitative and quantitative analysis of the substance, to prepare and standardize solutions of analytical reagents;
- take an average sample, to make the scheme of the analysis, to carry out the qualitative and quantitative analysis of substance within use of the basic receptions and methods provided by the program;
- work with the main types of devices used in the analysis (microscopes, photoelectrocolorimeters, spectrophotometers, potentiometers, conductometers, polarimeters, etc.);
- choose the optimal method of qualitative and quantitative analysis of the substance;
- build titration curves and establish on their basis the volumes of titrant consumed for each component of the mixture;
- separate cations and anions by chemical and chromatographic methods;
- conduct laboratory experiments, to explain the essence of specific reactions and their analytical effects, to draw up reporting documentation based on experimental data;
- perform initial calculations, final calculations using statistical processing of the results of quantitative analysis;
- work independently with educational and reference literature on analytical chemistry.
- demonstrate knowledge and practical skills in the discipline.

Have the skills in:

- application of modern technologies to search for scientific and professional information; analysis, generalization and systematization of information;
- creation and edit professional texts, participate in professional discussions and debates, logically argue their views;
- choice the methods of conducting scientific research; use methods of mathematical analysis and modeling, theoretical and experimental research in pharmacy;
- organization and carry out quality control of medicines in accordance with the requirements of the current State Pharmacopoeia of Ukraine and good practices in pharmacy;
- choice the optimal chemical and physico-chemical methods of drug quality analysis;
- planning and conducting qualitative and quantitative analysis of the substance within the use of basic techniques and methods provided by the program.

4. Content and logistic of the discipline

Form of education: full-time; or it can be changed to a distance form of education within the terms established by the law in connection with martial law and Covid-19.

Module 1 Qualitative analysis. Acid-base titration	III semester 120 hours / 4 credits	Lectures № 1-7 Practical classes № 1-30 Topics for self-study: according to program of discipline
Module 2 Quantitative analysis. Instrumental methods of analysis	IV semester 105 hours / 3,5 credits	Лекції № 8-14 Практичні заняття № 31 -59 Topics for self-study: according to program of discipline

The course includes 31 topics, which are divided into 2 modules and 8 content modules.

Module 1. Qualitative analysis. Acid-base titration

Content module 1. Analytical chemistry and chemical analysis. Theories of solutions of strong and weak electrolytes. The law of mass action and its application to different types of ionic equilibrium. Application of the law of mass action to equilibrium in heterogeneous systems and its significance in analytical chemistry. Theory and practice of analysis of cations of I-III analytical groups.

Topic 1. Introduction to qualitative analysis.

Topic 2. The theory of strong electrolytes. Heterogeneous equilibrium.

Topic 3. Theory and practice of analysis of cations of I-III analytical groups.

Content module 2. Application of the law of mass action to the acid-base equilibrium and to the equilibrium of complex formation, their role in analytical chemistry. Theory and practice of analysis of cations of IV-VI analytical groups.

Topic 4. Acid-base equilibria in analytical chemistry.

Topic 5. Equilibria in complexation reactions.

Topic 6. Redox equilibrium in analytical chemistry.

Topic 7. Theory and practice of analysis of cations IV-VI analytical groups.

Content module 3. Application of the law of mass action to redox equilibrium. Methods of separation and concentration. Theory and practice of analysis of anions and unknown sample.

Topic 8. Theory and practice of analysis of anions, methods of separation and concentration.

Topic 9. Analysis of compounds of unknown composition.

Content module 4. Acid-base titration and its application in chemical and pharmaceutical analysis.

Topic 10. Introduction to quantitative analysis. Weighing technique. Titrimetric methods of analysis. Acid-base titration.

Topic 11. Acid-base titration. Titration of strong acids with strong bases and vice versa.

Topic 12. Acid-base titration. Titration of weak acids with alkalis and weak bases with strong acids.

Topic 13. Acid-base titration. Titration of polybasic acids, multiacid bases, mixtures of acids or bases.

Topic 14. Acid-base titration. Titration of ampholytes.

Topic 15. Acid-base titration. Application of acid-base titration for quantitative determination of chemicals and drugs. Statistical processing of analysis results.

Topic 16. Final lesson from the section "Titrimetric methods of analysis. Acid-base titration».

Module 2. Quantitative analysis. Instrumental methods of analysis

Content module 5. Redox titration and its application in the analysis of chemical compounds and drugs.

Topic 1. Redox titration. Permanganatometry.

Topic 2. Redox titration. Iodimetry, iodometry.

Topic 3. Redox titration. Bromometry, bromometry.

Topic 4. Redox titration. Nitritometry.

Topic 5. Final lesson from the section "Titrimetric methods of analysis. Redox titration».

Content module 6. Precipitation titration, compleximetric titration. Gravimetric analysis. Application of methods in the analysis of chemical compounds, cosmetics and medicines.

Topic 6. Precipitation titration. Argentometry. Mercurimetry.

Topic 7. Compleximetric titration. Complexonometry.

Topic 8. Gravimetric analysis. Application of gravimetry for analysis of chemicals and drugs.

Topic 9. Final lesson from the section "Sedimentation, compleximetric titration. Gravimetric analysis».

Content module 7. Optical methods of analysis.

Topic 10. Optical methods of analysis. Photocolorimetry and spectrophotometry. Conditions for photometric determination. Determination of the concentration of the test solution

Topic 11. Optical methods of analysis. Refractometry. Polarimetry

Topic 12. Final lesson from the section "Optical methods of analysis".

Content module 8. Electrochemical methods and Chromatographic methods of analysis.

Topic 13. Electrochemical methods of analysis. Potentiometric analysis. Potentiometric titration.

Topic 14. Chromatographic methods of analysis. Determination of alkali metal salts in solutions by ion exchange chromatography. Thin layer chromatography.

Topic 15. Final lesson from the sections "Electrochemical and chromatographic methods of analysis".

The topics of the lecture course reveal the problematic issues of the relevant sections of the discipline. Practical classes provide a theoretical justification of the main issues of the topic and the acquisition of the following practical skills:

- 1) getting to know the main methods of qualitative and quantitative analysis medicinal substances;
- 2) organization of the workplace;
- 3) sampling for analysis;
- 4) analysis of the substances using chemical, physical, physical and chemical methods;
- 5) implementation of the necessary calculations to assess the quantitative content of substance;
- 6) formulation of conclusions based on the obtained results of qualitative and quantitative analysis of the substance in the sample.

The student's independent work provides preparation for practical classes and intermediate tests,

study of topics for independent extracurricular work, writing essays, preparation of presentations, tables. The control of mastering the topics of independent extracurricular work is carried out at the intermediate control classes and the final control of the discipline.

Individual work includes the study of scientific literature, preparation of reviews on the topics provided for presentation at the meetings of the student scientific circle, the implementation of scientific and practical researches, participation in specialized competitions, scientific and practical conferences and organization of students' research works.

Thematic plans of lectures, calendar plans of practical classes, thematic plan of independent extracurricular work, volume and directions of individual work are published on the website of the department.

The route for obtaining materials: Department of Pharmaceutical Chemistry / for students / Full-time education / (specialty 226 Pharmacy, Industrial Pharmacy) / 3rd (4th, 5th) course / Educational materials / or through the link <https://www.vnmu.edu.ua/en/> department of

Pharmaceutical Chemistry #. Access to the materials is carried out through the student's corporate account s000XXX@vnmdu.edu.ua.

5. Forms and methods of monitoring academic performance

Current control in practical studies	Methods: <i>oral or written survey, testing, electronic survey, solving situational problems, conducting laboratory studies, interpreting them and evaluating their results (drawing up a protocol in a workbook)</i>
Control of mastering the thematic section of the discipline at intermediate control lessons	Methods: <i>oral or written survey, electronic testing, situational problem solving, control of practical skills</i>
Final semester control at the end of the III semester - <i>credit</i>	According to the Regulation of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link https://www.vnmdu.edu.ua/en/general-regulations)
Final control of the discipline - <i>exam</i>	Methods: pre-examination testing, oral questioning (according to the Regulation of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link https://www.vnmdu.edu.ua/en/general-regulations)
Learning success diagnostic tools	Theoretical questions, tests, situational tasks, practical tasks, practical skills demonstration

6. Assessment criteria

Knowledge assessment is carried out in accordance with the Regulations of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link <https://www.vnmdu.edu.ua/en/general-regulations>)

Continuous assessment	On a four point system of traditional assessments: 5 «excellent», 4 «good», 3 «satisfactory», 2 «unsatisfactory»
Midpoint separation assessment	On a four-point system of traditional assessments
Control of practical skills	According to the four-point system of traditional assessments
Pass-fail exam	On a 200-point scale (the arithmetic average grade for the semester is converted into points) Credited: 120 to 200 points Not credited: less than 120 points (See Grading Scale)
Final control of the discipline	<i>Sum of points for pre-examination testing (12-20 points) and oral questioning (38-60 points) (for disciplines included in Step 1,2)</i> Exam grade: 71-80 points - "excellent" 61-70 points - "good" 50-60 points - "satisfactory" Less than 50 points - "unsatisfactory" / did not pass
Discipline assessments:	Current academic assessment - from 72 to 120 points (conversion of the average traditional assessment of practical class on a 120-point scale): 60% of the grade for the discipline Final control - from 50 to 80 points: 40% of the grade

	for the discipline Individual work - from 1 to 12 points From 122 to 200 points in total.
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Discipline Score Scale: National and ECTS

The sum of grades for all types of educational activities	Score ECTS	Score on a national scale	
		For exam, course project (work), practice	for credit test
180-200	A	excellent	credited
170-179,9	B	good	
160-169,9	C		
141-159,9	D	satisfactory	
122-140,99	E	satisfactory	-
122-140,99	E	-	credited
0-121,99	FX	unsatisfactory with the possibility of reassembly	is not credited with the possibility of reassembling
	F	unsatisfactory with a mandatory reexamination of discipline	is not credited with mandatory reexamination of discipline

7. Policy of discipline / course

The student has the right to receive high-quality educational services, access to contemporary scientific and educational information, qualified advisory assistance during the study of discipline and mastering practical skills. The policy of the department during the providing of educational services is a student-centered, based on normative documents of the Ministry of Education and the Ministry of Health of Ukraine, the Statute of the University and the Procedure for the Providing of Educational Services regulated by the main principles of the organization of the educational process in National Pirogov Memorial Medical University, Vinnytsya and the principles of academic integrity (link <https://www.vnmu.edu.ua/en/general-regulations>).

Adherence to the rules of VNMU, safety techniques in practical classes.

Requirements for preparation for practical classes. Student should be present at the practical lesson on time, theoretically prepared according to the topic, adhere to the necessary for work in the laboratory form of clothing (medical gown, if necessary - hat, gloves, etc.). When performing a laboratory work, it is necessary to strictly follow the rules and safety precautions, experiments are possible only in the presence of a teacher or laboratory assistant in the classroom. Show tolerance, courtesy, tact and respect to other participants during the discussion.

Usage of mobile phones and other electronic devices. The use of electronic devices is allowed, but limited to individual cases. It is allowed to use these devices for testing on the Microsoft Teams platform, for mathematical calculations ("Calculator" function), for processing literary sources in electronic form (agreement with teacher is required). It is forbidden to use electronic devices during classes for photo, audio and video recording without the consent of all participants of the educational process, for entertainment purposes, as well as during an oral survey.

Academic integrity. When studying the discipline, the student must be guided by the Code of Academic Integrity and Corporate Ethics of National Pirogov Memorial Medical University, Vinnytsya (link: <https://www.vnmu.edu.ua/en/general-regulations/> Code of Academic Integrity). In case of violation of the norms of academic integrity during the current and final controls student receives a grade of "2" and must work it out to his teacher in the prescribed manner within two weeks after receiving an unsatisfactory assessment).

Missed classes. Missed classes are working out in the manner prescribed by Regulations of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link <https://www.vnmu.edu.ua/en/general-regulations/>) at the time of work out schedule (published on the website of the department <https://www.vnmu.edu.ua/> department of Pharmaceutical Chemistry #) to the teacher on duty. To work out missed lesson student must provide permission from the dean's office, pass multiple choice questions (MCQ) on a missed topic and recitation, work out laboratory work (if the latter is in a particular topic), draw up a laboratory report and defend it to the teacher on duty.

Note. To ensure the completion of the laboratory works, it is necessary to apply in advance to the laboratory assistant of pharmaceutical chemistry department and indicate the topic and specific date of rework to prepare the necessary reagents, laboratory utensils, etc.

The reworks of missed lectures are carried out to the lecturer of the subject, with the permission of the dean, the abstract of the lecture, a short recitation on the topic of the lecture is possible.

The procedure for admission to the discipline final control is given in the Regulations of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link <https://www.vnmu.edu.ua/en/general-regulations>). To the final control allowed students who do not have missed practical classes and lectures and received an average traditional grade of at least "3".

Additional points. Individual points in the discipline (from 6 to 12) that student can receive for individual work, the amount of which is published on the website of the department in the educational methodical materials of the discipline, the number of points is determined by the results of IRS according to Regulation of the Academic process in National Pirogov Memorial Medical University, Vinnytsya (link <https://www.vnmu.edu.ua/en/general-regulations>).

Conflict resolution. In case of misunderstandings and complaints to the teacher because of the quality of educational services, knowledge assessment and other conflict situations, student should submit his / her claims to the teacher. If the issue is not resolved, the student has the right to apply to the head of the department according to Complaints Consideration Procedure in VNMU named after M.I. Pirogov (link <https://www.vnmu.edu.ua/en/general-regulations>)

Politics in terms of remote learning. Distance learning regulated by the Regulations of the elements of remote learning in National Pirogov Memorial Medical University, Vinnytsya (<https://www.vnmu.edu.ua/> General information). The main training platforms for studying are Microsoft Team and Google Meets. Practical classes and lectures, exercises and consultations during distance learning is published on the website of the department ([https://www.vnmu.edu.ua/en/ Department of Pharmaceutical Chemistry / to Students](https://www.vnmu.edu.ua/en/Department%20of%20Pharmaceutical%20Chemistry%20to%20Students) or [https://www.vnmu.edu.ua/en/Department of Pharmaceutical Chemistry / News](https://www.vnmu.edu.ua/en/Department%20of%20Pharmaceutical%20Chemistry%20News)).

Feedback from teachers is via messengers (Viber, Telegram, WhatsApp) or e-mail (at the teacher's choice) during working hours.

Educational resources.

1. Educational and methodological support of the discipline is published on the website of the department ([https://www.vnmua.edu.ua/en/department of Pharmaceutical Chemistry / for students](https://www.vnmua.edu.ua/en/department-of-pharmaceutical-chemistry/)). Consultations are held twice a week according to the schedule.
2. **The timetable and distribution of groups** with assigned teachers are published on the web page of the department ([https://www.vnmua.edu.ua/en/department of Pharmaceutical Chemistry / for students](https://www.vnmua.edu.ua/en/department-of-pharmaceutical-chemistry/)).
3. Questions to the intermediate and final semester control (credit) of the discipline are published on the web page of the department ([https://www.vnmua.edu.ua/en/department of Pharmaceutical Chemistry / for students](https://www.vnmua.edu.ua/en/department-of-pharmaceutical-chemistry/)).

The syllabus of the discipline "Analytical Chemistry" was discussed and approved at the meeting of the department of Pharmaceutical Chemistry (record № 1, dated "01"_09_2022)

Responsible for the academic
discipline



Senior teacher
Albina KOSAREVA

Head of the Pharmaceutical
Chemistry Department



Assoc. prof. of HEI
Tetyana YUSHCHENKO