FacultY OF PHARMACY

STUDY PROGRAM 0916.1 PHARMACY

CHAIR OF GENERAL CHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum faculty of Pharmacy
Minutes No.___ of _____
Chairman, PhD, associate professor

Uncu Livia _____

APPROVED
at the Council meeting of the Faculty of Pharmacy
Minutes No.___ of _____
Dean of Faculty, PhD, associate professor

Ciobanu Nicolae _____

APPROVED
approved at the meeting of the chair of
General chemistry
Minutes No. 3 of 10.09.2021
Head of chair, PhD, associate professor

Cheptanaru Constantin _____

SYLLABUS

DISCIPLINE **PHYSICAL AND CHEMICAL METHODS OF ANALYSIS**

Integrated studies

Type of course: **Compulsory**

Syllabus was elaborated by:

Oprea Vasile, PhD, associate professor.

Chisinau, 2021

I. PRELIMINARY

- **General presentation of the discipline: the place and role of the discipline in the formation of specific competences of the professional/ specialty training program**

  Physical and Chemical Methods of Analysis curriculum for pharmacist qualification is a normative pedagogical document and a didactic tool for the efficient organization of the educational process elaborated on the basis of the Framework Program for Pharmaceutical Higher Education in the Republic of Moldova, based on the University Charter of PI "Nicolae Testemitanu" State University of Medicine and Pharmacy, Regulations for organization of studies in higher education based on the National Credit Studies System, no.1 / 8 of 06.04.2017, Regulation for evaluation and academic performance in State University of Medicine and Pharmacy "Nicolae Testemitanu", no.5 / 4 of 12.10.2016, in coordination with the curriculum of the pharmaceutical discipline (pharmaceutical chemistry, drug technology, pharmacology, etc.).

  Physical and Chemical Methods of Analysis (PhChMA) is a fundamental discipline, the study of which at the pharmaceutical higher education stage is intended for the students of the pharmacy faculty and is the basis for the study of disciplines (pharmaceutical chemistry and drug analysis). The PhChMA study process is organized by implementing different methods of analyzing pharmaceutical forms.

- **The mission of the curriculum (purpose) in professional training**

  The syllabus for the indicated discipline is foreseen for the students of the pharmacy faculty and aims at the training, completion and deepening of the knowledge of the pharmacists students on the theoretical and practical bases of the contemporary methods of physicochemical analysis. The theoretical knowledge and practical skills accumulated by the students in the completion of the curriculum in this discipline will essentially contribute to the following subjects: pharmaceutical chemistry, pharmacognosis, drug technology, biological chemistry, etc., as well as to the completion of the bachelor's degree programs. The basic book of each pharmacist is the Pharmacopoeia, where for each drug is described the classical or instrumental method of analyzing the active substance in each drug. This is why the pharmacist student must also know the Physical and Chemical Methods of Analysis.

- **Teaching language**: Romanian, Russian, English;

- **Beneficiaries**: 2rd year students, Pharmacy faculty.

II. ADMINISTRATION OF THE DISCIPLINE

Code of discipline		**S.04.O.035**	
Name of the discipline		**Physical and Chemical Methods of Analysis**	
Responsible for discipline		PhD, associate professor **Oprea Vasile**	
Year	**II**	Semester / Semesters	**IV**
Total hours, including:			**120**
Course	**15**	Practical / laboratory hours	**45**
Seminars	**-**	Self-training	**60**
Evaluation form	**E**	Number of credits	**4**

III. TRAINING OBJECTIVES IN THE DISCIPLINE

At the end of the discipline study the student will be able to:

- ***at the level of knowledge and understanding:***
  - to know the fundamental properties and basic laws on which the development of related analysis methods is based. For example, the basis for all spectrophotometric methods of analysis is the interaction of the substance with electromagnetic radiation.
  - to know the basic principles of classification of the electrochemical analysis methods.
  - to know the fundamental law on the absorption of the electromagnetic radiation and different calculation and graphic analysis spectrophotometric methods of analysis: graphic calibration method, absorbance comparison method, standard addition method and differential method.
  - to know the particularities of the appearance of the analytical signal in different electrochemical methods of analysis such as: direct and indirect potentiometry, polarography and amperometric methods of analysis, coulometry.
  - to know the structure, classification and basic characteristics of indicator electrodes, used in electrochemical analysis methods.
  - to understand that the analysis of many chemical systems starts from the separation of the components of the mixture and that chromatography is a dynamic process that takes place in a system of two immiscible phases, one of them mobile and one fixed.
  - to understand that column elution chromatography allows not only to separate chemical substances and pharmaceutical preparations from a mixture of them, but also the possibility to record the analytical signal, which is directly proportional to the concentration of each component of the mixture.

- ***at the level of application:***
  - to apply the theoretical knowledge obtained in plotting the graphs based on the data obtained from the laboratory work on the physicochemical methods of analysis and their interpretation.
  - to train themselves in solving different problems by multilaterally processing the gained information.
  - to deduct and to apply on the basis of the theoretical knowledge obtained of the calculation formulas in the study of different methods of analysis
- ***at the level of integration:***
- to appreciate the importance of the course "Physicochemical methods of analysis" in the context of integration with the disciplines (pharmaceutical chemistry, drugs technology, toxicological chemistry, drug control, etc.).
- to possess skills to implement and integrate the knowledge gained in the discipline of physical-chemical methods of analysis with other specific profile disciplines.
- to argue in finding the most rational physicochemical method for analyzing a mixture of drugs.

IV. PRELIMINARY CONDITIONS AND REQUIREMENTS

Curriculum - general and inorganic chemistry, quantitative analytical chemistry, physical chemistry, pharmaceutical biophysics.
Skills - the ability to conduct experiments, the ability to understand and correctly apply working methods, in compliance with occupational safety standards.

Students of the second year must possess:

- Knowledge of the teaching language.
- Digital skills (use of the Internet, document processing, electronic tables and presentations, use of graphics software).
- Communication and team work ability.
- Qualities - tolerance, compassion, autonomy.
- Obligatory attendance of the student at the Physical and Chemical Methods of Analysis, at all laboratory work and quizzes.
- The students' delay in the course and the practical lessons will not be tolerated because it interrupts and disturbs the educational process.
- Students will be present at lectures with closed mobile phones. Talks will not be tolerated during the lecture.
- The term of the teaching of the laboratory work is determined by the teacher in agreement with the students. Claims for its annulment on unfounded grounds will not be accepted.

V. ORIENTATIVE TIMETABLE AND ORIENTATIVE DISTRIBUTION OF HOURS

Courses (lectures), practical works / laboratory works / seminars and individual work

№	Theme	Number of hours		
		Lectures	Practical work	Individual work
1.	Analytical signal. Classification of the physico – chemical methods of analysis (chemical methods, physico – chemical methods and physical methods).	1	3	-
2.	Electromagnetic radiation. Dual nature of the electromagnetic radiation. Spectrum of electromagnetic radiation.	1	3	4
3.	The substance structure and the origin of the atomic and molecular spectra.	1	3	4
4.	Molecular absorption spectroscopy. The Bougher – Lambert - Beer law. Absorbance and transmittance.	1	3	4
5.	Presentation of absorption spectra. Deviations from the Bougher-Lambert-Beer Law. The law of additivity.	1	3	4
6.	Determination of optimal conditions for elaboration of new methods of spectrophotometric analysis. **Quiz no.1.**	1	3	4
7.	Luminescence as a method of quantitative analysis.	1	3	4
8.	Electrochemical analysis methods. Classification, electrochemical and electrolytic cells. Potentiometry.	1	3	4
9	Membrane electrodes. Exchange constant. The basic characteristics of an ion-selective electrode.	1	3	4
10	The polarographic method. Polarogram registration conditions. Polarogram and its characteristics. Ilkovici equation.	1	3	4
11	Heirovski - Ilkovici relationship. Quantitative and qualitative polarographic analysis. Voltammetry. **Quiz no.2.**	1	3	4
12	Coulometric analysis method. Coulometric analysis method.	1	3	4
13	Chromatography: the essence of the method. Chromatographic features. Peak resolution.	1	3	6
14	Chromatography theory. Qualitative and quantitative chromatographic analysis.	1	3	4
15	Ion exchange chromatography. Partition and high-performance liquid chromatography. **Quiz no.3.**	1	3	6
Total		**15**	**45**	**60**

VI. REFERENCE OBJECTIVES AND CONTENT UNITS

Objectives	Content units
Chapter 1. Spectrophotometric analysis methods	
• to define the fundamental law of absorption of electromagnetic radiation and the law of absorption summation. • to know the appearance of the analytical signal in spectrophotometric analysis methods. • to define molar absorbance and specific absorbance. • to know how to measure the absorbance of the solution with an optical device. • to draw conclusions. • to comment on the results obtained in comparison with the classical methods of analysis studied. • to know the equations of the fundamental law, summation and transmission.	The Bougher-Lambert-Beer and the summation law. The exponential and logarithmic equation of the fundamental law. Absorbance, transmittance, molar absorbance and specific absorbance. Absorbance measurement with a photoelectrocolorimeter: analysis solution, comparison solution, incandescent bulbs, radiation filters, sample chamber, signal detector, signal indication. Absorbance measurement errors. Spectrophotometric analysis methods: calibration curve method, comparison method, addition of a standard for spectrophotometric titration, differential and titration based on the molar absorbance value. Luminescence analysis.
Chapter 2. Electrochemical analysis methods	
• to know the types of cells used in the analysis. • to know the classification of the analysis methods after the measured parameter. • to demonstrate the particularities of ion-selective and glass electrodes. • to differentiate the basic characteristics of a membrane electrode. • to know the basic diagrams of electrochemical analysis methods. • to develop skills in plotting and interpretation of graphs and in calculating analysis results.	Electrochemical and electrolytic cells. Direct and indirect potentiometric method. Nernst equation. Gran method. Determination of the equivalence volume of the titrant by the graphical method. Indicator and reference electrodes. Membrane electrodes (ion-selective) and their characteristics. Voltammetry and polarographic method. The platinum electrode and the mercury dropping electrode. Polarographic analysis method and amperometric titration method with one and two indicator electrodes. Titration curves and determination of the titrant's equivalence volume. Potentiostatic technique and galvanostatic coulometric analysis. The Faraday Law. Coulometric titration method. Obtaining titrants from solvent and auxiliary reagents. Reactions to electrodes and solutions. Calculation Formulas.
Chapter 3. Chromatographic analysis methods	

Objectives	Content units
• know the essence of chromatography. • understand the column separation processes. • know the characteristics of chromatographic peak (s). • know the theories of chromatography. • demonstrate liquid chromatographic techniques.	The essence of chromatography. Mobile phase and stationary phase. Types of column chromatograms: internal, frontal and elution. Chromatographic features. Characteristics of chromatographic peaks: retention time, width and shape. Quantitative chromatographic analysis by column elution. Liquid Chromatography: ion exchange, partition and high-performance liquid Chromatography (HPLC).

VII. PROFESSIONAL COMPENTENCES (SPECIFIC (SC) AND TRANSVERSAL (TC)) STUDY FINALITIES

✓ Professional competences (specific) (SC)

- SC1.Knowledge of the theoretical bases of the discipline "Physicochemical methods of analysis" and the acquisition of some theoretical and practical skills in the instrumental analysis of substances, the control of drugs, and other products in performing the analysis in the laboratories of pharmaceutical, toxicological and biochemical chemistry.
- SC2. Acquiring experience and gaining practical skills in handling laboratory equipment specific to physicochemical methods of analysis.
- SC3. Use and knowledge of calculation formulas in various instrumental analysis methods of both active substances in a drug, as well as chemicals and other products. Possessing the computer as a working tool in the theoretical and practical work of the future pharmacist.
- SC4. Acquiring practical skills in the processing of experimental data obtained in different instrumental analysis methods, constructing functional dependencies and extracting the necessary data for calculating the final results of the respective analysis method and formulating the conclusions.
- SC5. Formulation of the abilities to use elaboration methodologies and techniques specific to the physicochemical methods of analysis. Capabilities to solve the situation problems in the pharmaceutical activity.
- SC6. Adoption of messages in various socio-cultural environments, including through multi-language communication.

✓ Transversal Competences (TC)

- TC1. Professional development.
- TC2. Using theoretical notions in solving problems.
- TC3. Acquiring critical thinking skills.
- TC4To know and apply ethical principles related to pharmaceutical practice.
- TC5. Develop teamwork skills.
- TC6. Communicate orally and in writing the requirements, the way of work and the results obtained.
- TC7. To use information and communication technologies.

✓ **Study outcomes**

- To know the particularities and classification of the physico-chemical methods of analysis.
- Understand the way in which the analytical signal appears in different physico-chemical methods of analysis.
- Understand the processes that flow into the solution and the indicator electrodes.
- To be able to deduce the formulas for calculating the results of the analysis as well as the information obtained after the processing of the experimental data and building the functional dependencies on different themes of the laboratory works.
- Be able to evaluate the place and role of the discipline physico-chemical methods of analysis in the professional training of the future pharmacist.
- Be competent to use scientific information with confidence, using new information and communication technologies.
- To know the essence, the theories and the classification of the chromatographic methods of analysis.

VIII. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation Strategies	Evaluation criteria	Deadlines
1.	Working with information sources.	Carefully reading the lecture or course material in the subject. Reading questions on the subject, which require a reflection on the subject. To get acquainted with the list of additional information sources on the topic. Select the source of additional information for that theme. Reading the text entirely, carefully and writing the essential content. Wording of generalizations and conclusions regarding the importance of the theme / subject.	Ability to extract the essentials; interpretative skills.	During the semester
2.	Working with the problem notebook.	Problem solving in the subject of laboratory work.	Volume and accuracy of solved problems.	During the semester
3.	Report	Analysis of relevant sources on the topic of the paper. Analysis, systematization and synthesis of information on the proposed theme. Compilation of the	The quality of systematization and analysis of the informational material obtained through its	During the semester

		report in accordance with the requirements in force and presentation to the chair.	own activity. Concordance of the information with the proposed theme.	

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-EVALUATION

- ***Teaching and learning methods used***

Discipline Physical and Chemical Methods of Analysis are taught in classical ways: lectures, practical and laboratory work. At the lectures, the theoretical course will be read by the course holders. In practical and laboratory work, students will broaden, deepen and verify the theoretical knowledge, will have principles and methods easily accessible for instrumental and quantitative analysis, will pay attention to the laboratory work. The Department reserves the right to spend some practical work in an interactive manner.

- ***Applied didactic strategies / technologies*** *(specific to the discipline)*

In order to be successful in studying the discipline of Physical and Chemical Methods of Analysis, the student has to work actively both at the courses and the laboratory, as well as on his own, and the teacher has to use the didactic technologies specific to the discipline. The most important methods in teaching the PhChMA are problematization, experimental and brainstorming.

Brainstorming is a group creativity technique designed to generate a large number of ideas to solve a problem.

Problematization also called teaching through problem solving or, more specifically, teaching through productive problem solving. A didactic method consisting of putting in the minds of the deliberately created difficulties in overcoming which, by their own effort, the student learns something new.

The laboratory experiment is a method of acquiring knowledge and training skills and skills of intellectual and practical work, it allows an intensive activity of the student and a particularly active participation of the student in the educational process, has a pronounced applicative character with weight particular in the formation of practical skills.

- ***Evaluation methods*** *(including an indication of how the final mark is calculated)*

Current: frontal and / or individual control through

1. applying the tests,
2. solving problems / exercises,
3. analysis of case studies
4. quizzes.

Final:

The final exam is at the end of the IV semester. The final exam is a computer-based testing.

The final exam mark is calculated by the computer testing mark (exam) (50%) and the average mark for the semester (50%). The average mark for the semester is based on total points earned for quizzes and student self-training.

At the final exam are not admitted students with the annual average under grade 5, as well as students who have not recovered absences from practical and laboratory work. The average grade is calculated from the notes of three quizzes and individual work.

Exam subjects are approved at the chair meeting and are brought to the attention of the students at least one month before the session.

Methods of mark rounding at the evaluation steps

Intermediate note grid (annual average, grades from the exam stages)	National scoring system	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-8,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all the final examination (computer assisted) - all will be expressed in numbers according to the scoring scale (see table), and the final mark obtained will be expressed in two decimal digits which will be transferred to the report card.

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to re-take the exam twice.

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X. RECOMMENDED LITERATURE:

A. Compulsory:

1. STEVEN S. ZUMDAHL. *Chemistry.* Lexington, Massachusetts, Toronto, 1986/
2. FRANCIS MARION MILLER. *Chemistry, Structure and dynamics.* McGraw-Hill book company, USA., 1984/

B. Additional:

1. ДОРОХОВА Е.Н, ПРОХОРОВА Г.В. *Аналитическая химия. Физико-химические методы анализа.* М.: „Высшая школа”, 1991.
2. БУЛАТОВ М.И., КАЛИНКИН И.П. *Практическое руководство по фототетрическим методам анализа.*Л.: „Химия”, 1986.
3. VASILIEV V.P. „*Analytical Chemistry, 2nd vol*. (Chimie analitică,vol.2). Instrumetal analysis methods (Metodeinstrumentale de analiză). „ Universitas ”Chişinău, 1991.
4. LIVIU ROMAN. ROBERT SĂNDULESCU. „*Analytical Chemistry, 3rd volume*, (Chimiaanalitică, vol.3), edituraDidacticăşiPedagogică R,A., Bucureşti,1999.
5. VASILE OPREA, CONSTANTIN CHEPTĂNARU. „*Colection of methods recommended to be used in the practical laboratory work of the discipline „Physico-chemical analysis methods*” (Culegere de indicaţiimetodice la lucrările practice şi de laborator la disciplina „ Metode fizico-chimice de analiză”), CEP, „ Medicina”, Chişinău, 2014.