Approved

At the meeting of the Council of Faculty of Pharmacy
Minutes No. 4 of 12. 06. 2014

Dean of the Faculty of Pharmacy
PhD, associate professor _____ N. Ciobanu

Approved

At the meeting of the chair of General Chemistry
Minutes No. 11 of 06. 06. 2014

Head of the chair,
PhD, associate professor _____ C. Cheptănaru

SYLLABUS FOR STUDENTS OF

FACULTY OF PHARMACY

Name of the course: **Physical Chemistry**

Code of the course: **F030030**

Type of course: **compulsory**

Total number of hours – 85

lectures - 34 hours, practical lessons - 51 hours

Number of credits provided for the course: **14**

Lecturers teaching the course: **PhD, associate professor – Sârbu Vasile**

senior lecturer – Jora Elena

Chisinau 2014

I. Aim of the discipline:

The principal goal of the course of Physical Chemistry for the students of Faculty of Pharmacy is to study those branches of physical chemistry that form the theoretical basis for the deeper and more complete understanding of biochemistry, physiology, pharmaceutical chemistry, pharmacology, the technology of medicines, toxicological chemistry.

II. Objectives obtained in teaching the discipline:

- At the level of knowledge and understanding

the course should enhance the student's ability

- to understand the goals and objectives of physical chemistry, means and methods of their accomplishment;
- to know the theoretical fundamentals of physical and physical chemical processes, occurring in various chemical reactions;
- to understand and to interpret (explain) the basic energy parameters of chemical and biochemical processes, their role in defining the direction and completeness of their course, the methods of calculation chemical equilibria constants.

- At the level of application

the course should enhance the student's ability

- to apply physical and physical chemical methods while studying chemical systems;
- to define the direction of the chemical reaction course on the basis of thermodynamic constants;
- to calculate thermodynamic and kinetic parameters in order to study various chemical processes;
- to solve situational problems, processing critically multilaterally acquired information;
- to predict the possible spontaneous course of processes and the shifts of chemical equilibria.

- At the level of integration

the course should enhance the student's ability

- to apply the knowledge, acquired in the course of physical chemistry, in the following core subjects: biochemistry, physiology, pharmaceutical chemistry, pharmacology, the technology of medicines, toxicological chemistry;
- to widely apply the acquired knowledge for the multitude of physical chemical research methods, frequently used in pharmacy;
- to estimate the significance of physical chemistry in the field of pharmacy;
- to define the connection between physical chemistry and other pharmaceutical disciplines;

- to be able to acquire new directions and achievements in pharmaceutical discipline.

III. Provisional terms and conditions:

The primary goal of contemporary physical chemistry is to determine the detailed mechanisms of phenomena, to study and explain the main principles that define the direction of chemical processes, the speed of their course, the environmental impact they undergo, to establish the connection between the substance structure and the capacity of its reactions.

The determination of chemical structure and the clarification of its connection with the biological activity represents on the most significant objectives of pharmacy, which are to be solved by means of physical chemistry.

IV. Main theme of the course:

Physical Chemistry is a 1-semester credit class.

A. Lectures:

№.	***Themes***	Hours
	Semester III	
1	Introduction. The subject of physical chemistry and its significance in pharmacy. Mathematical expression of the first law of thermodynamics for real and ideal gases. The connection between the changes of enthalpy and internal energy. The dependence of reaction enthalpy and temperature. Kirchhoff's equation.	2
2	The second element of thermodynamics and its mathematic expression. Entropy and its changes within spontaneous chemical processes. Entropy change in isolated systems. The probability of the system state and its connection with entropy. The statistical nature of the second law of thermodynamics.	2
3	Gibbs energy (isobaric-isothermal potential) and Helmholtz energy (isochoric-isothermal potential) and their connection with maximal useful work. Thermodynamic conditions of equilibrium. The motion of chemical potential.	2
4	The law of mass action for homogeneous and heterogeneous chemical equilibrium. Isotherm equation of chemical reaction and its analysis. Isochore and isobar equations of chemical reaction. The corollaries of these equations.	2
5	Thermodynamics of heterogeneous equilibria. The Clausius-Clapeyron equation. Phasic transformations and equilibria. Gibbs phase law. Phase diagrams of monocomponent systems. Diagrams of two-component systems melting. Thermic analysis.	2
6	Diagrams: structure – vapour pressure and structure – boiling temperature. Konovalov's first and second laws. The reciprocal dissipation of liquids. Nernst-Shilov's distribution law. Extracting.	2
7	Thermodynamic properties of diluted solutions. The correlation between the colligative properties of solutions: the relative lowering of vapour pressure, the depression of freezing point, elevation of	2

	boiling and osmotic pressure of diluted solutions of electrolytes and nonelectrolytes. Cryoscopic, ebullioscopic and osmotic methods of measuring molecular masses, osmotic concentration of a solution, isotonic and osmotic coefficients.	
8	Electrochemistry. Conductors of the first and the second type. Specific and equivalent electric conductivity of solutions and their dependence on the dilution. Kohlrausch's Law. Conductometric definition of degree and dissociation constant of a weak electrolyte, the coefficient of electric conductivity of a strong electrolyte, the ionic product of water, solubility of badly dissolved electrolytes. Conductometric titration.	2
9	Electrode potential. The mechanism of electric double layer formation. Nernst equation for electronic potential calculation. Types of electrodes. Hydrogen and standard hydrogen electrodes. Reverse and unreverse galvanic cells. The dependence of electromotive force on electrolyte concentration.	2
10	Calomel and silver chloride electrodes. The measuring of electrode potentials and electromotive force of galvanic cells.	2
11	Concentration chains. Diffusive and membrane potentials. Reduction-oxidation redox) electrodes. Potentials and standard potentials of redox-electrodes.	2
12	Ion selective electrodes. Glass electrode. Potentiometric measurement pH. Potentiometric titration. Potentiometric definition G and Kp.	2
13	Electrolysis and electrode processes. Chemical and density polarization. Polarography and its application in pharmacy.	2
14	Kinetics of chemical reactions. Chemical reactions rate and the methods of its measurement. The dependence of reaction rate on various factors. Reaction molecularity and order. Equations for the rate constant of zero, first and second -order reactions. Half-life period.	2
15	The methods of defining reaction order. The collision theory. The activation energy. Arrhenius equation. Methods of defining pharmaceutical drugs shelf-life. The theory of transition state.	2
16	Complex reactions: parallel, competing and sequential. Chain reactions. Photochemical reactions. Einstein Law of Photochemical Equivalence. Reaction quantum yield.	2
17	Properties of heterogeneous reactions. The rate of heterogeneous reactions and the factors, determining it. Kinetic and diffusion fields of the heterogeneous process. Catalytic reactions. Positive and negative catalysis. Mechanism of catalysts reaction. Catalytic reactions activation energy. Acid-base catalysis. Biocatalysis. Heterogeneous catalysis theories (A.A.Balandin, N.I. Kobzev, S.Z.Rogozonsky, F.F.Volkenstein.	2

B. Practical lessons:

№	***Themes***	Hours
	Semester III	
1	Rules and reculations regarding students' activity in Physical Chemistry Laboratory. Demands for students' reports (records) presentation. Knowledge evaluation of the topic : Elements of chemical thermodynamics. Problem solving.	3
2	Measuring enthalpy changes of salt hydration process ($CuSO_4$, $MgSO_4$,	3

	Na_2CO_3, $ZnSO_4$, $CuCl_2$).	
3	Seminar. The first and the second laws of thermodynamics. Energy functions of state.	3
4	The study of the chemical equilibrium of homogeneous reaction.	3
5	Test-paper N 1. a) Chemical thermodynamics elements. b) The first and the second laws of thermodynamics. c) Energy functions of state. d) Thermodynamics of chemical equilibrium.	3
6	The diagram of pharmaceutical drugs binary mixture melting (aspirin-phenacetin system).	3
7	Drawing the diagram boiling temperature – binary fluid mixtures structure (alcoholic tinctures).	3
8	The study of I2 extraction process. Measuring I2 partition coefficient between water and benzole.	3
9	Cryometric measurement of isotonic coefficient and ionization degree of a weak acid (chloroacetic, oxalic, aminoacetic, malonic, dichloroacetic) in water solution	3
10	Conductometric measurement of ionization degree and constant of a weak electrolyte (CH_3COOH).	3
11	The measuring of electrode potential and electromotive forces of galvanic cells (Ag/AgCl, KCl//KCl//$ZnSO_4$/Zn and Ag/AgCl, KCl//KCl//$CuSO_4$/Cu).	3
12	Potentiometric method of pH measurement. Hydrochloric acid potentiometric titration. Potentiometric definition of ionization constant of weak acids (CH3COOH).	3
13	Redox- system $[Fe(CN)_6]^{3-}$ $[Fe(CN)_6]^{4-}$ standard potential measuring.	3
14	Test-paper N 2. Thermodynamics of phasic equilibria. Colligative properties of solutions. Thermodynamics of electrode processes. Application of electrochemical methods of analysis. Reduction-oxidation potentials. Concentration galvanic cells.	3
15	Chemical Kinetics. Determining the coefficient of hydrolysis of sucrose reaction rate.	3
16	Chemical Kinetics. Determining the coefficient of hydrogen peroxide dissociation reaction rate in the presence of MnO_2 catalysis.	3
17	Concluding lesson	3

V. Recommended literature:

- A. compulsory:

1. Беляев А.П., Кучук В.И., Евстратова К.И., Купина Н.А., Малахова Е.Е. Физическая и коллоидная химия. Москва, 2010.
2. К.И.Евстратова. Физическаяиколлоиднаяхимия. М.”Высшаяшкола”,1990.
3. Grigore Junghiety, V.Sârbu. Chimie Fizică. Chisinău, 1996.

4. Р.А. Дулицкая, Р.И.Фельдман. Практикум по физической и коллоидной химии. М, ”Высшая школа”, 1978.
5. В. А. Сырбу. Методическое пособие к решению задач (МПР3) по физической химии. ч.1,2,3,4. Кишинёв, 1985.
6. V.Sârbu. E.Jora. Culegere de lucrări practice si de laborator la chimiefizică, “CEP Medicina”, Chisinău, 2012.
7. В. А. Сырбу. Методические разработки по физической химии (электрохимия и электрохимические методы исследования). Кишинёв, 1989.
8. Vasile Sârbu. Material didactic la chimia fizică. Electrochimie. Chisinău, 1992.
9. В. А. Сырбу. Сборник методических указаний по физической химии. Кишинёв, 1989.

- B. additional:

1. Ludovic Kurunczi. Curs de chimie fizică si coloidală pentru farmacisti. Editura Mirton, Timisoara, 2000.
2. Emil Făgărăsan, Silvia Imre. Chimie fizică experimentală. Editura Medicală Universitară”Iuliu Hartiegalu”. Cluj-Napoca, 2005.
3. StefanMoisescu. Chimiefizică. Sistemefarmaceutice.Ed. Universitară “Carol Davila” ,Bucuresti, 2003.
4. Gavril Niac, Ossi Horovitz, Ioana Muresan. Chimie fizică. Vol 1,2. Editura U.T. Press, Cluj-Napoca, 2001.
5. Constantin Ionescu. Chimie fizică. Ed. Didactică si Pedagogic, Bucuresti, 1982.
6. Краткий курс физической химии, С.М.Кочергин и др. Москва, Высшая школа, 1979.
7. Victor Isac s a. Chimie fizică. Lucrări practice. Chisinău, Stiinta, 1995.
8. Victor Isac s a. Chimie fizică. Cinetică chimică si cataliză. Chisinău, Stiinta, 1994.
9. Киреев В.А. “Краткий курс физической химии”. М., Химия, 1978.
10. Хмельницкий Р. А. Физическая и коллоидная химия, М., 1988.
11. Florica Dima, Maria Vasilescu. Lucrări practice de chimie fizică. Iasi, 1984.

VI. Teaching and learning methods:

A course of Physical Chemistry is taught in a classical manner, which includes theoretical lectures and practical lessons. During the lectures the theoretical information of the course is presented. At practical laboratory classes students study the most necessary and significant laboratory works, followed by the report presentation and the explanation of the obtained results and the application of the corresponding physical chemical methods, frequently used in pharmacy.

VII. Suggestions for individual activity:

From the pedagogical point of view, the passive acquisition of the course is considered to be one of the least effective methods of teaching, even if it is thoroughly structured and illustrated.

Carrying out practical assignments is regarded to be more effective, than the ordinary explanation of how it should be performed, and teaching this work to the others is considered to be the most effective.

To understand successfully the course of Physical Chemistry it is necessary to work actively in the laboratory, which means:

1. At first you should read the new information very thoroughly, not simply looking through it. If it is necessary, take some notes in the workbook. Try to formulate the main ideas, using your own words. Study the schemes and pictures in the textbook. Answer the questions and fulfill the tests from the textbook or the assignment book.
2. Come to the lecture and the practical class, but not just for the sake of being present. Otherwise you won't be able to acquire the new material. Take the notes carefully. Analyze the new information, constantly asking yourself whether you agree with the lecturer, whether you understand everything and whether the presented information doesn't contradict that written in the textbook.
3. Keep on asking the lecturer, each other, yourself various questions. Ask questions in the classroom, laboratory, hall, and the instructor's office. The mere fact of question asking means that you try to figure out and understand the themes under consideration, which is greatly welcomed. Come to the tutorials and consultations according to the schedule.
4. Join into two(three)-person groups in order to discuss lecture and laboratory classes material, to prepare for the seminars and final test-papers. It is acknowledged that working in a group you understand and acquire the information much better. Besides, the skills of explaining the themes to your comrades will be of great use in the future.
5. Use your time rationally. The course of physical chemistry as well as other disciplines that are taught this year sets very high demands. Therefore, you have to find the golden mean between your studies, other duties and personal life. According to the established rules, students are to work one hour directly with the instructor and 2 or 3 hours independently. In other words, for the successful acquisition of the course of Physical Chemistry a student has to study independently 5 hours a week.
6. The individual study of Physical Chemistry implies the analysis of the problems that have been solved, as well as the knowledge control by means of solving the thematic problems, that are included in the textbook or the assignment book
7. The search for the correct answers to the tests presents another method of studying and understanding of theoretical and practical material.

VIII. Methods of assessment:

1 seminar and 2 test-papers are planned for the one-term course of Physical Chemistry. Final test-papers are held in written form, according to the test-paper cards, which have the following structure: a theoretical question, a problem, 10 test items with one correct answer and 10 test items with several answers. The maximal number of point is indicated at each.

Each test-paper and seminar can be taken not more than two times. Besides, one attempt is possible at the end of each term (the last week). The average grade for the term presents in itself the arithmetic mean of the test-papers and seminar grades.

The students with the average term grade less than 5, 0 as well as those who haven't recovered the absence from the laboratory works are not admitted to the exam.

There are two stages in the exam: testing (20 tests) and oral answer (a student is allotted 30 minutes for the preparation)

At the oral examination a student is offered an examination card, which comprises 2 theoretical questions and one problem to solve.

Both stages are graded from "0" to "10"

The examination questions are approved at the chair meeting and are displayed a month before the examination session.

The final grade is made up of three components: the average grade for the year (coefficient 0, 5), oral examination (coefficient 0, 3), testing (coefficient 0, 2)

Methods of mark rounding

The average of current and final marks	Final mark
5	**5**
5,1-5,5	**5,5**
5,6-6,0	**6**
6,1-6,5	**6,5**
6,6-7,0	**7**
7,1-7,5	**7,5**
7,6-8,0	**8**
8,1-8,5	**8,5**
8,6-9,0	**9**
9,1-9,5	**9,5**
9,6-10	**10**

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.

IX. Language of study:

Romanian, Russian, English