

**AGROBIOLOGICAL FACULTY  
DEPARTMENT OF ANALYTICAL AND BIOINORGANIC CHEMISTRY  
& WATER QUALITY**

**“CONFIRMED”**

Dean of Faculty of Veterinary Medicine,  
Academician of the Ukrainian Academy of Agrarian Sci,  
Doctor in biology, Professor  
M. I. Tsvilikhovskiy  
“ ” , 2022



**«APPROVED»**

At the meeting of the department  
of Analytical and Bioinorganic  
Chemistry & Water Quality  
Protocol # 12, “23” May, 2022

Head of the Department  
Dr.Chem.Sci, Prof. V.A. Kopilevich

**«REVIEWED»**

Guarantor of Educational Program Veterinary Medicine  
Dr. Veterinary Sci, Associate Prof. N.G. Grushanska

**SYLLABUS**

**Academic Discipline  
“INORGANIC CHEMISTRY”**

**Speciality – 211 Veterinary Medicine**  
**Educational Program – Veterinary Medicine**  
**Faculty Veterinary Medicine**  
**Syllabus was created by: Associate Prof. Cand. Chem Sci L.V. Voitenko**

Kyiv, 2022

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**NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES  
OF UKRAINE**

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# 1. ACADEMIC DISCIPLINE DESCRIPTION INORGANIC CHEMISTRY

(назба)

<b>Field of knowledge, specialty, educational program, educational level</b>		
Educational level	Master	
Speciality	211 – Veterinary Medicine	
Educational program	Veterinary Medicine	
<b>Characteristics of the educational program</b>		
Type	Ordinary (standard)	
The total number of academic hours	120	
Number of modules	3	
Number of ECTS credits	4	
Forms of control	Written Exam	
<b>Indicators of academic discipline for full-time and part-time forms of training course</b>		
	Full-time	Part-time
Year of study (course)	1	No
Semester	1	
Lectures	15 hours	
Laboratory training	45 hours	
Independent study	60 hours	
Number of weekly in-class academic hours for full-time forms of training	3	

## 2. GOAL, OBJECTIVES, AND COMPETENCES OF THE ACADEMIC DISCIPLINE

Inorganic chemistry is the study of inorganic matter and the changes it undergoes in alive bodies.

The discipline studies the theoretical foundations of contemporary Inorganic Chemistry and data about features of bio-elements such as Hydrogen, Halogens, Oxygen, Sulfur, Nitrogen, Phosphorus, Carbon, Tin, Lead, Boron, Aluminum, Alkaline and Alkaline-earth metals, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Molybdenum, Silver, Mercury, Cadmium, Chromium, Strontium. Chemical processes with these elements and its compounds are shown on the points of view theory of electrolytic dissociation, hydrolysis, redox processes and possibility of complex compound formations. In the labs it is shown the foundations of qualitative tests of mentioned above compounds of bio-elements and its using in the practice of veterinary medicine.

The argument has been made that inorganic chemistry is not a separate branch of chemistry, but simply the application of chemical knowledge (fig. 1).

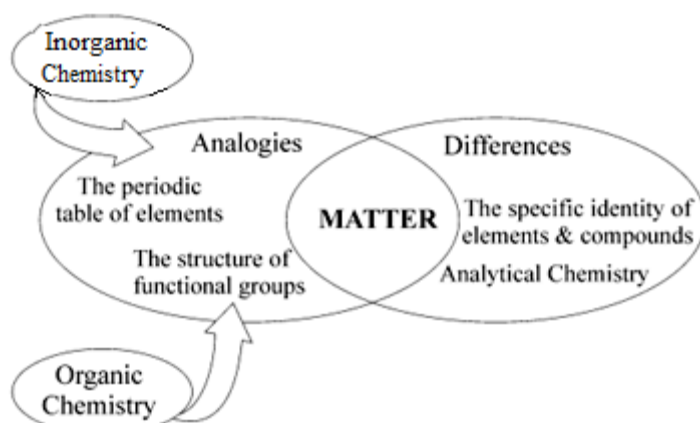


Figure 1 – Inorganic Chemistry as the Chemistry of the differences

In fact, students probably have performed foundations of chemistry of elements in other chemistry courses. For example, many introductory courses in chemistry include qualitative schemes for identifying inorganic ions and quantitative analyses involving titrations.

In general:

- Veterinarians use chemistry to diagnose disease in sick and apparently healthy animals.
- Additionally, veterinarians use chemistry to prescribe medications and treatments for sick animals and monitor response to the treatment.
- One of the most common applications for chemistry occurs when veterinarians analyze test results.
- Veterinarians use their knowledge of chemistry to interpret many diagnostic tests. For example, veterinarians may investigate the pH of an animal's blood.

So, Inorganic Chemistry is united with other chemical sciences with common chemical laws and based on studying of chemical properties of substances. Samples are diverse in nature and include mineral rocks, soils, air, animal tissues, plants, agrochemicals, water, fuel, blood, and medicines.

**The Objects of Inorganic chemistry research:**

- To empower students to obtain a skills orientated qualification - laboratory technician in biochemical analysis;
- To train veterinary scientists to be employed in various sectors of the animal production ;
- To train specialists for research activity in veterinary;
- To create further opportunities in research and for post-graduate studies;
- To make a national and international contribution to the promotion of research.

In general, *Inorganic chemistry* is the study of the composition, structure, and the properties of substances and the changes they undergo. This definition may suggest to you that chemistry has little to do with everyday life. This is not true. Your way of life would be radically different without the practical applications of

chemistry. Imagine a supermarket offering only fruits and vegetables grown without manufactured fertilizers and pesticides. The quantities and varieties offered would be far fewer. Imagine drinking water from your tap that had not been purified. The unpurified water would probably make you sick. Try to imagine a world without gasoline or heating oil. It would be very different from the world we live in.

A relative new direction of inorganic chemistry is *Inorganic chemistry*. Advances in inorganic chemistry since the 1970s have been driven by three factors: rapid determination of high-resolution structures of proteins and other biomolecules, utilization of powerful spectroscopic tools for studies of both structures and dynamics, and the widespread use of macromolecular engineering to create new biologically relevant structures. Today, very large molecules can be manipulated at will, with the result that certain proteins and nucleic acids themselves have become versatile model systems for elucidating biological function.

Oxidation-reduction processes continue to be a central theme of biological inorganic chemistry. Well over half of the papers in this special feature deal with biological red-ox reactions in one way or another.

So, to study a course of inorganic chemistry is to understand the basic principles of acid-base processes, reactions in the water medium (dissociation, hydrolysis), red-ox reactions, complexing reactions and so on.

Practical using of the knowledge and skills in inorganic chemistry is the basis for the **applied problems solution in veterinary medicine**, especially in:

- Risk analysis during production and processing of animal products and the development of veterinary-sanitary standards to ensure their safety and quality in accordance with modern requirements;
- Scientific support livestock production in concordance with the requirements of Codex Alimentarius;
- Chemical risks monitoring to ensure the production of safe output of good quality;
- Determination of chemical toxicants in products of animal origin and their impact on food safety indicators;
- Effect of water-soluble form of vitamin E on the safety and quality of products of animal origin; development of scientific and methodological approaches to chemical risk analysis during manufacturing, processing and circulation of food and feed products so that to harmonize legal acts.

### ***Control of knowledge and skills***

It is realized in the form:

- Control of lab works preparation;
- Theoretical control tests;
- Control experimental problems;
- Final written exam.

## ***Requirements to the knowledge and skills***

### **Student must to know:**

- Safety technique in chemical laboratory;
- Bases of the atomic-molecular studies;
- Chemical properties and biological activities of the main classes of inorganic substances;
- Processes in water solutions (electrolytic dissociation, hydrolysis);
- Notion of a pH, measuring, biological application and features;
- Units of concentration expressing; recalculations;
- Preparation of solutions of different concentration;
- Analytical tests of the basic inorganic cations and anions;
- RedOx theory; chemical ideas of redox processes for realization of biochemical processes (photosynthesis etc.);
- Theory of complex compounds; their biological role; isomerism of complex compounds; preparation and properties.

### **Student must to be able to do:**

- To carry out the chemical experiment using semimicro techniques;
- To compile the equations of chemical reaction of different types (neutralization, simple and double replacing (metathesis); redox; complexing)
- To solve quantitative calculations in concentration of solution;
- To prepare the solution of certain concentration.

### **Student must to have practical skills:**

- Use the educational, methodical and reference literature sources in the field of inorganic chemistry;
- to carry out calculations according to chemical reactions, to carry out chemical experiment by itself;
- To present results of experimental exercises in the form of protocol;
- To make calculations using the computers,
- To prepare equipment, glassware, reagents for analysis;
- To conduct qualitative and quantitative chemical analyses according to methodical rules;
- To carry out a mathematical processing of quantitative analyses, to estimate the mistakes of analysis;
- To present results of experimental exercises in the form of protocol.

### **Pre-required courses**

Course	Chapters of course
Advanced secondary school level	Knowledge in the volume of natural specialization (biology and chemistry) of secondary school
Organic chemistry	Organic dyes and ligands, indicators
High Mathematics	Logarithms and operations with logarithms, degree function
Biophysics	Atomic structure

### 3. PROGRAM AND STRUCTURE OF SUBJECT

#### Titles, contents, and extents of the lectures

#### **Змістовий модуль 1. General theoretical notions of Inorganic Chemistry**

**Lecture # 1.** Introduction. Subject and tasks of Inorganic Chemistry. Chemistry for veterinary medicine.

Atomic-molecular study. The mole concept in chemical calculations. General stoichiometric laws. Allotropy on the example of Carbon (especially fullerenes). Types of chemical reactions in inorganic chemistry.

**Lectures # 2-3.** The atomic theory and chemical bonding for inorganic compounds. Evolution of atomic ideas. The dual nature of electron. Atomic orbital. Laws of electron distribution around nucleus. The Klechkowsky's rule. Electron formulas. Valency as a function of electron structure. Excited state. Quantum numbers. S-, p-, d- and f-elements. "Octet" configuration and oxidation numbers. Types of chemical bonding. Mechanism of formation. Biological role of hydrogen bonding. Electronegativity and its using for calculation of chemical bond type. Mendeleev Periodical Table of the chemical elements and Periodical Law.

#### **Змістовий модуль 2. General Laws of chemical transformations without change of oxidation degree**

**Lecture # 4.** Units of Concentration: percent (mass) concentrations (percentage weight by weight; volume by volume etc; Molar, Normal (equivalent), and Titre. Formulas of recalculations of concentration units. Preparation of solutions.

**Lecture # 5.** Processes in water solutions. The main foundations of electrolytic dissociation theory. Degree of dissociation. Strong and weak electrolytes. Ostwald's dilution Law. Ionic reactions. The main electrolytes in body fluids. Electrolytic drinks.

Water as an electrolyte. Ionic product of water. Notion of pH. Measuring pH. Hydrolysis of Salts. Buffer solutions.

#### **Змістовий модуль 3. General Laws of chemical transformations with change of oxidation degree or valence**

**Lecture # 6.** Redox reactions as processes of electron transfer. Compiling equations of redox reactions. Typical oxidizing and reducing agents. Metals and non-metals as redox agents. Classification of redox reactions. Acids as strong oxidating agents – reacting of metals. Redox reactions in qualitative analysis. Redox reactions in nature and bodies.

**Lecture # 7.** Verner's Theory of Complex compounds, their chemical nature, type of chemical bonding, isomerism. Coordinative compounds in Chemical qualitative

analysis. Coordinative compounds in nature. Bioinorganic systems as complex compounds.

**Lecture # 8.** Endemic diseases. Biogeochemical zoning. Human and animal endemic diseases as the results of the abnormal distribution of the chemical elements in the environment.

#### 4. SUBJECT STRUCTURE

##### Program and structure of the subject

Назви змістових модулів і тем	Кількість годин					
	Денна форма					
	усього	у тому числі				
		лек	практ	лаб	інд	Сам. робота
1	2	3	4	5	6	7
<b>Змістовий модуль 1. General theoretical notions of Inorganic Chemistry</b>						
<b>Тема 1.</b> Introduction. Subject and tasks of Inorganic Chemistry. Chemistry for veterinary medicine. Atomic-molecular study. The mole concept in chemical calculations. General stoichiometric laws. Allotropy on the example of Carbon (especially fullerenes). Types of chemical reactions in inorganic chemistry. Introduction test.	10	2		4		4
<b>Тема 2.</b> The atomic theory and chemical bonding for inorganic compounds. Evolution of atomic ideas. The dual nature of electron. Atomic orbital. Laws of electron distribution around nucleus. The Klechkovsky rule. Electron formulas. Valency as a function of electron structure. Excited state. Quantum numbers. S-, p-, d- and f-elements. "Octet" configuration and oxidation numbers. Types of chemical bonding. Mechanism of formation. Biological role of hydrogen bonding. Electronegativity and its using for calculation of chemical bond type. Mendeleev Periodical Table of the chemical elements and Periodical Law. <b>Module test</b>	26	4		6		16
<b>Разом за змістовим модулем 1:</b>	<b>36</b>	<b>6</b>		<b>10</b>		<b>20</b>
<b>Змістовий модуль 2. Chemical transformations without change of oxidation degree</b>						
<b>Тема 3.</b> Units of Concentration: percent (mass) concentrations (percentage weight by weight; volume by volume etc; Molar, Normal (equivalent), and Titre.	34	4		18		12



1	2	3	4	5	6	7
<p>Formulas of recalculations of concentration units. Preparation of solutions.</p> <p>Processes in water solutions. The main foundations of electrolytic dissociation theory. Degree of dissociation. Strong and weak electrolytes. Ostwald's dilution Law. Ionic reactions. The main electrolytes in body fluids. Electrolytic drinks.</p> <p>Water as an electrolyte. Ionic product of water. Notion of pH. Measuring pH. Hydrolysis of Salts. Buffer solutions.</p> <p><b>Module test</b></p>						
<b>Разом за змістовим модулем 2:</b>	<b>34</b>	<b>4</b>		<b>18</b>		<b>12</b>
<b><u>Змістовий модуль 3. General Laws of chemical transformations with change of oxidation degree or valence</u></b>						
<b>Тема 4.</b> Redox reactions as processes of electron transfer. Compiling equations of redox reactions. Typical oxidizing and reducing agents. Metals and non-metals as redox agents. Classification of redox reactions. Acids as strong oxidating agents – reacting of metals. Redox reactions in qualitative analysis. Redox reactions in nature and bodies.	28	2		10		16
<b>Тема 5.</b> Verner's Theory of Complex compounds, their chemical nature, type of chemical bonding, isomerism. Coordinative compounds in Chemical qualitative analysis. Coordinative compounds in nature. Bioinorganic systems as complex compounds.	17	2		7		8
<b>Тема 6.</b> Endemic diseases. Biogeochemical zoning. Human and animal endemic diseases as the results of the abnormal distribution of the chemical elements in the environment.	5	1				4
<b>Разом за змістовим модулем 3:</b>	<b>50</b>	<b>5</b>		<b>17</b>		<b>28</b>
<b>Усього годин:</b>	<b>120</b>	<b>15</b>		<b>45</b>		<b>60</b>

#### 4. CHAPTERS OF SEMINAR TRAINING

No planned

#### 5. CHAPTERS OF PRACTICAL TRAINING

No planned

#### 6. LAB TRAINING CHAPTERS

#	Chapter	Hours
1	General rules of working in chemical laboratory. Security techniques. Using of semi-micro method in chemical experiment. Methods of chemicals purification. Control Test: Rest of secondary school	4
2	Principles of nomenclature and classification of inorganic elements and their inorganic compounds. Lab 1. Isolation of slightly soluble compounds – analogs of nature bio-active compounds. Structure of atoms of chemical elements. Electron formulas. Interdependence of biological function and physiological properties of elements and their atomic structure. <b>Module control test 1.</b>	6
3	Rules for equations combination in solutions of electrolytes. Lab 2. Preparation of weak electrolytes. Studing of reactions in solution. Rules for equations combination of hydrolysis process and determination of pH. Lab 3. Studing of salt hydrolysis. Indicator determination of pH. Reversibility of hydrolysis. Molecular and ionic reactions of salt hydrolysis, determination of pH. <b>Module control test 2.</b>	18
4	RedOx reactions, their classification. Methods of RedOx reaction compilation. Direction of RedOx reactions. Lab 4. Influence of medium to RedOx reactions. Studing of oxidation properties of Potassium Permanganate and Potassium Dichromate. RedOx reactions in Qualitative and Quantitative Analysis. Coordinate compounds of bio-metals. Lab 5. Preparation and studding of properties of coordination compounds of Copper, Iron, Cobalt, Zinc, Nickel. Reactions of coordination compounds in Qualitative and Quantitative Analysis. <b>Module control test 3.</b>	17
	Total	45

## 7. INDEPENDENT STUDY

#	Chapter	Hours
1	Modern concepts of inorganic chemistry. Bioactive compounds.	20
2	Main Concepts of Qualitative Analysis. Notion of Qualitative Chemical reagent, Qualitative test, sensibility of Qualitative test. Analytical classification of Cations and Anions. Main Concepts of Quantitative Analysis. Foundations of Neutralization method, Redox methods.	12
3	RedOx calculation of ionic species of metals of changing valencies in natural systems (iron, manganese). RedOx potential. Typical chemical disinfectants as strong oxidizing agents	16
4	Chelates as a food additives, drugs, and analytical reagents. Using of complexones in environmental sanitation.	8
5	General notions of Chemistry of Elements (main and secondary sub-groups) on the examples of basic bio-active elements	4
	<b>Total</b>	<b>60</b>

## 8. CONTENT OF THEORETICAL QUESTIONS

1. Subjects and tasks of inorganic chemistry.
2. The foundations of atomic-molecular theory. Notions of an atom, molecule, ion, simple and complex compounds, chemical formulas. Allotropy.
3. Types of the chemical reactions.
4. The laws of stoichiometry (law of Safe, Equivalentents etc).
5. The mole concept, Avogadro's Number. Relations of amount of substance, numbers of moles.
6. Evolution of atomic ideas.
7. The dual nature of electron.
8. Names and physical content of quantum numbers.
9. General rules for electronic formulas compilation - principle of energy minimum, Pauli exclusion Principle, Rule of Klechkovsky, Hund's Rule.
10. "Filling" of electrons on the examples Cu, Cr, Pd.
11. Electron formulas. Mechanism of exiting.
12. Valence as a function of electron configuration.
13. Types of the chemical bonding (ionic, covalent, metallic, hydrogen).
14. Abnormal water properties as a result of hydrogen bonding. Intermolecular hydrogen bonding in the structure of DNA double helix.
15. The Periodical Law and Mendeleev's Periodical Chart of the chemical elements.
16. Classification of inorganic substances.
17. Relations between the main classes of inorganic substances.
18. The amphoterity as acid-base duality.

19. The preparation and properties of the main classes (oxides, bases, acids, salts).
20. Structural-graphic formulas of chemical compounds. Examples.
21. Solutions. Basic units of concentration (mass concentration, molarity, normality, titer). Recalculations of units.
22. Theory of electrolytic dissociation.
23. Degree of dissociation. Strong and weak electrolytes.
24. Main classes of inorganic substances from viewpoint of theory of electrolytic dissociation.
25. Ionic reactions. Conditions of interactions in the solutions of electrolytes. Examples.
26. Ionic product of water. Notion of pH. Acid-base indicators.
27. Hydrolysis of salts. Types of hydrolysis. Determination of pH.
28. Notion of oxidation numbers. Types of Redox reactions.
29. Balancing of Redox reactions by method of electron balance.
30. Acids as strong oxidizing agents. Reactions of metals with acids.
31. Werner's theory of complex compounds.
32. Structure of complex compounds. Preparation of complex compounds.
33. Isomerism of complex compounds.
34. Endemic diseases of humans and animals as the result of chemical disproportionation of the non-biotic environment.

## 8. TEACHING METHODS

Before teaching a course, the instructor must identify what she or he intends for the students to learn. For most analytical chemistry instructors, this usually involves an assessment of what methods and techniques to include and at what depth to cover them. There are many other skills, though, that will be important to students for their future success. Most university classes in analytical chemistry are taught in a lecture format. An alternative to lecturing is the use of cooperative learning. Cooperative learning offers the potential to develop skills such as teamwork, communication, and problem-solving that are more difficult to impart in a lecture format. The laboratory component of analytical chemistry courses is often an underutilized learning resource. More often than not, the lab is used to demonstrate fundamental wet and instrumental analysis techniques and develop rudimentary laboratory skills. The analytical lab should also be used to develop meaningful problem-solving skills and to demonstrate and have students participate in the entire analytical process.

A teaching method comprises the principles and methods used for students teaching. Commonly used teaching methods for studying subject "Analytical chemistry" include on-time participation, demonstration, recitation, memorization, or combination of these. The choice of teaching method or methods to be used depends largely on the information or skill that is being taught, and it may also be influenced by the aptitude and enthusiasm of the students.

**Explaining, or lecturing**, is the process of teaching by giving spoken explanations of the subject that is to be learned. Lecturing is often accompanied by visual aids to help students visualize an object or problem.

**Demonstrating** is the process of teaching through examples or experiments. For example, a chemistry teacher must teach an idea by performing an experiment for students. A demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning.

Demonstrations in analytical chemistry and own experiment are permit to obtain experimental skills needed for environmental monitoring etc. Memorization of a list of facts is a detached and impersonal experience, whereas the same information, conveyed though demonstration, becomes personally relatable. Demonstrations help to raise student interest and reinforce memory retention because they provide connections between facts and real-world applications of those facts. Lectures, on the other hand, are often geared more towards factual presentation than connective leaning.

**Collaboration** allows students to actively participate in the leaning process by talking with each other and listening to other points of view. Collaboration establishes a personal connection between students and the topic of study and it helps students think in a less personally biased way. Group projects and discussions are examples of this teaching method. Teachers may employ collaboration to assess students' abilities to work as a team, leadership skills, or presentation abilities.

**Collaborative discussions** can take a variety of forms, such as fishbowl discussions. After some preparation and with clearly defined roles, a discussion may constitute most a lesson, with the teacher only giving short feedback at the end or in the following lesson.

Learning by teaching in the method, when students assume the role of teacher and teach their peers. Students who each others as a group or as individuals must study and understand a topic well enough to teach it to their peers. By having students participate in the teaching process, they gain self-confidence and strengthen their speaking and communication skills.

## 9. FORMS OF CONTROL

The main forms of knowledge control are control at the lectures at labs and workshops, outside the classrooms, and the consultations, tests and exams.

I. Control of the lectures can be conducted as a selective oral questioning of students or tests using the previously laid material, particularly in sections of the course that are necessary for the understanding of the lecture topics, read, or to establish a degree of mastery of the material lectures (held by the manner of the late first or early second hour lectures). Testing during lectures designed to teach students to systematic elaboration covered material and prepare for the upcoming lectures, establish the degree of assimilation theory to identify the most difficult students to read chapters from the following explanation of them. Control of their lectures has to subtract time. By spending time to control oral examination yields control, programmable for cards.

II. Current control on laboratory studies conducted to elucidate ready students for employment in the following forms:

1. Writing (30 min.). Control work.
2. Colloquium on separate sections of theoretical courses (modules or themes).

III. Credits. Some subjects (theoretical courses, practical training) is applied differential test of performance appraisal on a five point scale. In a lecture course or its individual parts, which are not accompanied by laboratory or practical classes, the teacher may conduct interviews or colloquium, offer oral or written questions. Often, students are subject to crediting as a minor, insignificant and do not give enough time to prepare for it. Of a major sources before credit of colloquium useful.

Term papers are the product of many days of work. They include elements of scientific research. Protecting course work – a special form of offset in the commission of two or three teachers. Best of course work submitted for scientific student conference.

IV. Examinations. Exam is a final step in the study of the whole or part of the discipline and are designed to test students' knowledge on the theory and identify the skills apply the acquired knowledge in solving practical problems, as well as independent work skills with educational and scientific literature.

Student's rating of knowledge of an academic discipline consists of training work rating – 70 points and final attestation – 30 points. Thus, rating of content modules, that are constituents of an academic discipline, makes 70 points. Rating of content modules as well as attestation rating are also measured by 100-point-scale.

### Assessment and grading

#### Grading system: National scale

National grade	Grade according to national system	Percentage score
Відмінно	Excellent	90-100
Добре	Very good	82-89
	Good	74-81
Задовільно	Satisfactory	64-73
	Satisfactory enough	60-63
Незадовільно	Unsatisfactory	35-59
	Unsatisfactory – serious work is needed	0-34

## 10. TECHNOLOGY AND METHODOLOGICAL REQUIREMENTS

У робочому навчальному плані передбачено в одному навчальному семестрі лекцій – 15 годин, лабораторних занять – 30 годин та самостійної роботи - 30 година, що в сумі становить 75 годин (2, 5 кредитів ECTS).

Тривалість навчального семестру – 15 тижнів.

Поточний контроль			Рейтинг з навчальної роботи $R_{НР}$	Рейтинг з додаткової роботи $R_{ДР}$	Рейтинг штрафний $R_{ШТР}$	Підсумкова атестація (залік диференційний)	Загальна кількість балів
Змістовий модуль 1	Змістовий модуль 2	Змістовий модуль 3					
0-100	0-100	0-100	0-70	0-10	0-3	0-30	0-100

Відповідно до «Положення про кредитно-модульну систему навчання в НУБіП України», затвердженого ректором університету 03.04.2009 р., рейтинг студента з навчальної роботи  $R_{НР}$  стосовно вивчення певної дисципліни визначається за формулою

$$R_{НР} = \frac{0,7 \cdot (R_{ЗМ}^{(1)} \cdot K_{ЗМ}^{(1)} + \dots + R_{ЗМ}^{(n)} \cdot K_{ЗМ}^{(n)})}{K_{ДИС}} + R_{ДР} - R_{ШТР},$$

де  $R_{ЗМ}^{(1)}, \dots, R_{ЗМ}^{(n)}$  – рейтингові оцінки змістових модулів за 100-бальною шкалою;

$n$  – кількість змістових модулів;

$K_{ЗМ}^{(1)}, \dots, K_{ЗМ}^{(n)}$  – кількість кредитів ECTS, передбачених робочим навчальним планом для відповідного змістового модуля;

$K_{ДИС} = K_{ЗМ}^{(1)} + \dots + K_{ЗМ}^{(n)}$  – кількість кредитів ECTS, передбачених робочим навчальним планом для дисципліни у поточному семестрі;

$R_{ДР}$  – рейтинг з додаткової роботи;

$R_{ШТР}$  – рейтинг штрафний.

Наведену формулу можна спростити, якщо прийняти  $K_{3M}^{(1)} = \dots = K_{3M}^{(n)}$ . Тоді вона буде мати вигляд:

$$R_{HP} = \frac{0,7 \cdot (R_{3M}^{(1)} + \dots + R_{3M}^{(n)})}{n} + R_{ДР} - R_{ШТР}.$$

Навчальне навантаження студента для їх вивчення та засвоєння складає:

1-й модуль ( $R_1$ ) – 1,0 кредит ( $K_1$ )

2-й модуль ( $R_2$ ) – 1,0 кредит ( $K_2$ )

**3-й модель ( $R_3$ ) – 0,5 кредита ( $K_3$ )**

**Критерії оцінки змістових модулів:**

$R_1$  складається з 3-х лабораторних робіт, самостійної та контрольної роботи. Захист практичних робіт та виконання самостійної роботи оцінюються від 5 до 10 балів кожна. Контрольна робота № 1 та 2 оцінюється від 0 до 50 балів.

$R_2$  складається з 2 лабораторних робіт, самостійної та контрольної роботи. Захист практичної роботи та виконання самостійної роботи оцінюються від 5 до 10 балів кожна. Контрольна робота № 2 оцінюється від 0 до 50 балів кожна.

$R_3$  складається з 2 лабораторних робіт, самостійної та контрольної роботи. Захист практичної роботи та виконання самостійної роботи оцінюються від 5 до 10 балів кожна. Контрольна робота № 3 оцінюється від 0 до 50 балів.

**Рейтинг з додаткової роботи  $R_{ДР}$**  додається до  $R_{HP}$  і не може перевищувати 10 балів. Він визначається лектором і надається студентам рішенням кафедри за виконання робіт, які не передбачені навчальним планом, але сприяють підвищенню рівня знань студентів з дисципліни.

**Рейтинг штрафний  $R_{ШТР}$**  не перевищує 3 балів і віднімається від  $R_{HP}$ . Він визначається лектором і вводиться рішенням кафедри для студентів, які матеріал змістового модуля засвоїли невчасно, не дотримувалися графіка роботи, пропускали заняття тощо.

Для допуску до атестації студенту необхідно набрати з навчальної роботи не менше 60% з кожного змістового модуля, а загалом не менше, ніж 42 бали з навчальної роботи.

**Реальний рейтинг з дисципліни  $R_{дис}$** . Визначається за формулою:

$$R_{дис} = R_{HP} + R_{ат}$$

Форма контролю – залік.

Атестації з дисципліни в цілому оцінюються за 100 бальною шкалою.

## 11. REQUIRED AND RECOMMENDED LITERATURE

### Basic

1. Chambers, C., Holliday A.K. Modern Inorganic Chemistry. <http://www.torrentz.com/be251001769c5a5cebbaa177a46e524d225fdff2>
2. Glinka N.N. General Chemistry. Moscow: Nauka, 1966.
3. Inorganic Chemistry. Manual//Voytenko L., Kosmatiy V., Kopilevich V. - Kyiv: NAU Publish., 2004. - 148 pp.
4. Workbook for specialist' student in veterinary medicine. Subject Bio-Inorganic chemistry and examples of tests (part I). –NUBIP Publish., 2010. – 120 pp.
5. Workbook for specialist' student in veterinary medicine. Subject Bio-Inorganic chemistry and examples of tests (part II). –NUBIP Publish., 2010. – 100 pp.

### Supplemental

1. Vogel 's Textbook of macro and semimicro qualitative inorganic analysis, 5<sup>th</sup> Edition, revised by G. Svehla, Queen's University, Belfast, Longman Co., 1979.



2. О.І. Карнаухов, Д.О. Мельничук, К.О. Чеботько, В.А. Копілевич. Загальна та біонеорганічна хімія. – К.: Фенікс, 2001. – 678 с.

## 12. NORMATIVE LITERATURE

1. ISO 6353-2:1983 Reagents for chemical analysis – Part 2: Specifications – First series.
2. ISO 6353-2:1983/Add.2:1986(en) Reagents for chemical analysis — Part 2: Specifications — First series ADDENDUM 2.
- 3.

## 13. IT RESOURCES

1. VIPeR. Virtual inorganic pedagogical electronic resource: a community for teachers and students of inorganic chemistry. Bioinorganic chemistry. - <https://www.ionicviper.org/subdiscipline/Bioinorganic%20Chemistry>
2. Periodical Table - <http://www.webqc.org/periodictable.php>.
2. Calculator of Molar weight (FW) - <http://www.graphpad.com/quickcalcs/Molarityform.cfm>
3. Units convertor - <http://www.webqc.org/unitconverters.php>.
4. pH calculator - <http://www.webqc.org/phsolver.php>.
8. Sigma-Aldrich reagents - <https://www.sigmaaldrich.com/>