



**COURSE SYLLABUS**  
«ANALYTICAL CHEMISTRY»

**Degree of higher education - Bachelor**  
**Specialization 162 - „Biotechnology and bioengineering,,**  
**Educational programme,,Biotechnology and bioengineering,,**  
**Academic year 2, semester 3**  
**Form of study    full-time   (full-time)**  
**Number of ECTS credits   6**  
**Language of instruction    English   (Ukrainian, English, German)**

---

**Lecturer of the course**  
**Contact information of the**  
**lecturer (e-mail)**  
**Course page on eLearn**

**Ph. D. Lavrik Ruslan**

---

**ruslanlavrik@nubip.edu.ua**

**<https://elearn.nubip.edu.ua/course/view.php?id=2590>**

---

**COURSE DESCRIPTION**

*(up to 1000 printed characters)*

Analytical chemistry is the branch of chemistry dealing with the separation and analysis of chemical substances. Traditionally, analysis has been concerned largely with chemical composition, but it is coming more and more to include the determination of chemical structure and the measurement of physical properties. Analytical chemistry includes both qualitative and quantitative analysis. Qualitative analysis is concerned with what is present, quantitative analysis - with how much, exclusively with the analysis of inorganic materials. Nevertheless, analytical chemistry properly includes the analysis of organic material too. Analytical chemistry finds extensive application in the analysis of organic compounds, fertilizers, pesticides, agrochemicals, plants, soils, pharmaceuticals, biochemicals, body fluids, hair, the atmosphere, polluted water, foods, alloys, and in many other areas.

Analytical Chemistry is the Chemistry of the differences. From an analytical point of view, analogies of elements, of a same column or period of the periodic table, are left aside in the same way that analogy of organic compounds, having the same functional groups, in order to pay more attention to the specific identity of elements and compounds. In this sense, Analytical Chemistry is closer to the evidences of the life experiences than other chemical disciplines and it can be well understood by our students, who appreciate the different effects of sodium and potassium on soil fertility, in spite of the fact that both are alkaline elements, or the tremendous differences between the toxicity of methanol and ethanol, which have the small difference of a carbon and two hydrogen atoms.

## Competitions:

Competencies of the educational programme:

Integrative competency (IC): The ability to solve complex specialized problems and practical problems characterized by complexity and uncertainty in biotechnology and bioengineering, or in the learning process, which involves the application of theories and methods of biotechnology and bioengineering. \_\_\_\_\_

General competencies (GC):

3. Ability to communicate in a foreign language.

5. Ability to learn and master modern knowledge.

Professional (special) competencies (PC): \_\_\_\_\_

2. Ability to use thorough knowledge of chemistry and biology to the extent necessary to achieve others results of the educational program

5. The ability to conduct experimental research with improvement of biological agents, including to cause changes in the structure of the hereditary apparatus and functional activity of biological agents \_\_\_\_\_

Program learning outcomes (PLO) of the educational programme: \_\_\_\_\_

2. To be able to carry out qualitative and quantitative analysis of substances of inorganic, organic and biological origin, using appropriate methods.

22. Be able to take into account social, ecological, ethical, economic aspects, labor and industrial safety requirements sanitation and fire safety during the formation of technical solutions. Be able to use different types and forms of motor activities for active recreation and healthy living way of life.

## COURSE STRUCTURE

Topic	Hours (lecture/laboratory, practical/ self)	Learning outcomes	Tasks	Assessment
<b>1 semestr</b>				
<b>Module1</b>				
Lecture # 1. Subjects and objects of the chemical analysis (analytical chemistry).	2/2/4	What is necessary to know, What one should be able to do, What one should be concerned in: Methods of quantitative analysis – chemical and physical-chemical. Subjects of qualitative and quantitative analyses. Methods of qualitative analysis – macro-, semimicro-, micro-, and ultramicromethods.	LABORATORY TRAINING № 1. works preparation;	ol of lab works preparation; retical control tests; ol experimental problems;
Lecture # 2. Analytical reactions and requirements to analytical reactions. Examples of qualitative reactions of different visual effects (sedimentation, colorizing etc.).	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: “Dry” and “wet” qualitative tests. Pyrochemical methods (idea of borax bead tests, flame tests), microcrystalline analysis, analysis in drops in filter paper. Notions of specific, selective, and group reactions and reagents. Examples.	LABORATORY TRAINING № 2. Examples of qualitative reactions. works preparation;	ol of lab works preparation; retical control tests; ol experimental problems;
Lecture # 3. Principles of cations classification – acid-base, sulfide, ammine-phosphate.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: The main group reagents. Analytical purity of reagents. Ukrainian and international degrees	LABORATORY TRAINING № . works preparation;	ol of lab works preparation; retical control tests; ol experimental problems;

		of purity (classification техн, ч, чда, хч, осч; Analytical reagent AR, Guaranteed Reagent (GR) etc.).		
Lecture # 4. The methodology of cation mixture analysis.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Partial and Systematic analysis. Centrifugation, fullness testing.	LABORATORY TRAINING № 1. lab works preparation; tests;	Preparation of lab works; theoretical control tests; solution of experimental problems;
<b>Module2</b>				
Lecture # 5. Expression of Concentration:	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: percent (mass) concentrations (percentage weight by weight; volume by volume etc; Molar, Normal (equivalent), and Titr.	LABORATORY TRAINING № 1. lab works preparation;	Preparation of lab works; theoretical control tests; solution of experimental problems;
Lecture # 6. Formulas of recalculations of concentration units.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Preparation of solutions. Calculation in quantitative analysis.	LABORATORY TRAINING № 1 lab works preparation; experimental problems; tests; Control experimental problems;	Preparation of lab works; theoretical control tests; solution of experimental problems;
Lecture # 7. Heterogeneous equilibrium.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Equilibrium In Saturated Solutions of Slightly Soluble Substances. Solubility product. Molar and mass solubility. Examples of calculations.	LABORATORY TRAINING № 1 lab works preparation; experimental problems;	Preparation of lab works; theoretical control tests; solution of experimental problems;

Lecture # 8. Factors effecting solubility	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: temperature, common ion effect, pH effect. Notion of ionic power (strength), active coefficients, and active concentrations.	RATORY TRAINING Nº lab works preparation; works preparation;	ol of lab works preparation; etical control tests; ol experimental problems;
Lecture # 9. Subject of gravimetric analysis.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Equipment and tools (filter paper series). The experimental strategy. Calculations in gravimetric analysis. Tananaev's rule. Amorphous and crystalline sediments. Requirements to sediments in gravimetric analysis. Rules of sedimenting.	RATORY TRAINING Nºgravimetr ic analysis. works preparation; experimental problems; tests;	ol of lab works preparation; etical control tests; ol experimental problems;
Lecture # 10. Homogeneous equilibrium. Ionic product of water.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: pH notion. Biological function depending pH. Measuring pH. pH calculations of strong acids and bases, weak acids and bases.	RATORY TRAINING NºIonic product of water. lab works preparation; experimental problems;	ol of lab works preparation; etical control tests; ol experimental problems;
Lecture # 11. Hydrolysis and pH calculations of different salts solutions. Buffer solutions.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Calculate of a pH of buffer solutions. Titration curves, equivalent points, titration jump. Acid-base indicators.	RATORY TRAINING Nº lab works preparation; experimental problems;	ol of lab works preparation; etical control tests; ol experimental problems;

		Choice of indicators. Equivalent law in volumetry.		
Lecture # 12. Neutralization method.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Standard and working solutions, possibilities of method. Determination of water temporary hardness.	LABORATORY TRAINING Nº Neutralization method. lab works preparation; tests;	Preparation of lab works; theoretical control tests; solution of experimental problems;
Lecture # 13. RedOx volumetry. Nernst equation.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Electrode potential of redox systems. Electromotive force (EMF) of redox systems. RedOx indicators.	LABORATORY TRAINING Nº RedOx volumetry. Nernst equation. lab works preparation; experimental problems;	Preparation of lab works; theoretical control tests; solution of experimental problems;
Lecture # 14. Foundations of permanganometry and iodometry.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Bases of method of permanganometry and iodometry.	LABORATORY TRAINING Nº permanganometry and iodometry. lab works preparation; experimental problems;	Preparation of lab works; theoretical control tests; solution of experimental problems;
Lecture # 15. Complexometry. Bases of method.	2/4/4	What is necessary to know, What one should be able to do, What one should be concerned in: Standard and working solutions, possibilities of method. Metallochromic indicators. Determination of total temporary hardness. Precipitation titration. Mohr's method of chloride determination.	LABORATORY TRAINING Nº Complexometry. lab works preparation; experimental problems; tests;	Preparation of lab works; theoretical control tests; solution of experimental problems;

		Fixation of equivalent point. Experimental strategy.		
Total	30/60/98			
Course work	44			(70/30) 100
Всього за 1 семестр				70
Екзамен				30
Всього за курс				100

### ASSESSMENT POLICY

<b><i>Policy regarding deadlines and resits:</i></b>	Assignments submitted after the deadline without valid reasons will be graded lower. Resitting of modules will be allowed with the permission from the lecturer and in the presence of valid reasons (e.g. medical reasons).
<b><i>Academic honesty policy:</i></b>	Cheating during tests and exams is strictly prohibited (including the use of mobile devices). Coursework and research papers must contain correct citations for all sources used.
<b><i>Attendance policy:</i></b>	Class attendance is mandatory. In case of objective reasons (such as illness or international internships), individual learning may be allowed (in online format by the approval of the dean of the faculty).

### SCALE OF ASSESSMENT OF STUDENT KNOWLEDGE

Student rating, points	National grade based on exam results	
	exams	credits
90-100	excellent	passed
74-89	good	
60-73	satisfactory	
0-59	unsatisfactory	not passed

### Technology and methodological requirements

1. Analytical Chemistry: Tutorial : [for students of higher educational institutions III-IV accreditation level, speciality 162 Biotechnologies and Bio-engineering] / Voitenko L.V., Prokopchuk N.M., Lavrik R.V., – Kyiv: NULES Publ., 2018. – 402 p.
2. Introduction in General, Organic and Analytical Chemistry, 7<sup>th</sup> Edition, by Morris Hein, Leo R. Best, Scott Pattison and Susan Arena, Brooks/Cole Publishing Co., 2010, 872 pp.
3. Chemistry: the Molecular Nature of Matter and Change, 2<sup>nd</sup> ed. Martin S. Silberberg, McGraw-Hill Companies, 2000, 1086 pp.
4. Analytical Chemistry, second edition, D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman and Co., New York, 2017, 913 pp.

## Supplemental

1. Concepts and Models of Inorganic Chemistry, third edition, B. E. Douglas, D. H. McDaniel and J. J. Alexander; John Wiley & Sons, Inc., New York, 1994. 993 p.
2. Inorganic Chemistry, A Modern Introduction, T. Moeller; John Wiley & Sons, New York, 1982. 846 p.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw; Pergamon Press, New York, 1984. 1542 pp.

### Normative literature

1. ISO 6353-2:1983 Reagents for chemical analysis -- Part 2: Specifications -- First series.
2. ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method. ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method.
3. ISO 6059 – 1984 Water quality – Determination of the sum of calcium and magnesium – EDTA titrimetric method.

### IT resources

1. <https://elearn.nubip.edu.ua/course/view.php?id=1185>
2. <http://www.informika.ru/text/database/chemy/Enu/Data/Ch1-7.html>
3. <http://dbhs.wvusd.k12.ca.us/AcidBase/Kw.html>
4. <http://dbhs.wvusd.k12.ca.us/AcidBase/Hydrolysis.html>
5. <http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/bond.html>
6. <http://chemlab.pc.maricopa.edu/periodic/triangletable.html>
7. <http://www.pc.chemie.uni-siegen.de/pci/versuche/english/kapite14.html>