SYLLABUS
Spring semester 2024-2025 academic year
Educational program "6B05301 – Chemistry"

ID and name of the course	Independent work of the student (IWS)	Number of credits			General number of credits	Independent work of the student under the guidance of a teacher (IWST)
		Lectures (L)	Seminars (S)	Lab. classes (LC)		
100951 Analytical Chemistry	4	1.5	1.5	6	9	7

ACADEMIC INFORMATION ABOUT THE COURSE				
Learning Format	**Cycle, component**	**Lecture types**	**Types of practical classes**	**Form and platform final control**
Offline	Base, University	Analytical	Laboratory	Test in Univer system
Lecturer	Bulat Nurlanovich Kenessov			
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ACADEMIC COURSE PRESENTATION		
Purpose of the course	**Expected Learning Outcomes (LO) ***	**Indicators of LO achievement (ID)**
To learn the modelling of chemico-technological processes	1. Understand the core concepts and principles underlying analytical chemistry	1.1 Know the definition and importance of analytical chemistry
		1.2 Know types of analytical signal for qualitative and quantitative analysis
		1.3 Understand main specifications of analytical methods (precision, accuracy, sensitivity, selectivity)
		1.4 Understand the analytical process and its steps
	2. Understand chemical equilibria and their relevance to analytical chemistry	2.1 Know different forms of chemical compounds in liquid, gaseous and solid samples
		2.2 Understand theories of acids and bases, effects of pH on concentrations of different forms of analytes in aqueous solutions
		2.3 Understand the effect of different parameters on the partitioning of analytes between different phases, calculate equilibrium concentrations of analytes in different phases
		2.4 Application of homogeneous and heterogeneous equilibrium in analytical chemistry
	3. Understand and compare various classical and instrumental analytical techniques, their principles, instrumentation, applications, advantages, and limitations	3.1 Understand principles of identification of inorganic cations and anions
		3.2 Understand principles, instrumentation, applications, advantages and limitations of titrimetric methods of analysis
		3.3 Understand principles, instrumentation, applications, advantages and limitations of gravimetric methods of analysis

		3.4 Understand principles, instrumentation, applications, advantages and limitations of electrochemical methods of analysis
		3.5 Understand principles, instrumentation, applications, advantages and limitations of spectroscopic methods of analysis
		3.6 Understand principles, instrumentation, applications, advantages and limitations of chromatographic methods of analysis
		3.7 Compare classical and instrumental analytical techniques
	4. Demonstrate proficiency in basic laboratory techniques used in analytical chemistry, including sample preparation, solution preparation, calibration, data collection, and handling analytical instruments	4.1 Know and apply basic techniques of sampling and sample preparation
		4.2 Know main glassware and equipment for chemical analysis, and their specification
		4.2 Prepare gaseous, liquid and solid samples with known concentrations of chemical substances at a desired uncertainty
		4.3 Obtain and use calibration curves
		4.4 Collect and record analytical data
		4.5 Handle analytical instruments
	5. Process, analyze, and interpret experimental data using appropriate statistical methods, including error analysis, calibration curves, and statistical tests	5.1 Understand principles of statistical methods
		5.2 Estimate the quality of calibration curves
		5.3 Estimate accuracy, precision and uncertainty of results of analysis and each stage of analysis
		5.4 Find outliers in analytical measurements
		5.5 Report the results of analytical measurements
		5.6 Identify and minimize potential sources of errors
	6. Solve various problems using analytical chemistry	5.1 Choose the most suitable techniques of sampling, sample preparation and analysis
		5.2 Improve existing and set up new analytical methods in an analytical laboratory
Prerequisites	General chemistry, Physical chemistry	
Postrequisites	No	
Learning Resources	**Literature:** 1. Harris D.C. Quantitative Chemical Analysis, 9th edition. – New York: W.H. Freeman, 2015. 2. Pawliszyn J. Comprehensive Sampling and Sample Preparation: Analytical Techniques for Scientists. – Academic Press, 2012. **Research infrastructure** 1. Laboratory rooms at the Faculty of Chemistry and Chemical Technology 2. Laboratory rooms at the Center of Physicochemical Methods of Research and Analysis **Professional scientific databases** 1. NIST Chemistry webbook, https://webbook.nist.gov/chemistry/ 2. SciFinder, https://scifinder.cas.org **Internet resources** 1. Web of Science, https://webofscience.com 2. Scopus, https://scopus.com 3. Google Scholar, https://scholar.google.com 4. Mendeley, https://www.mendeley.com	

	5. ResearchGate, https://www.researchgate.net 6. Interactive lecture “Concentrations of chemical substances”. https://ecobio.cfhma.kz/conc1/story_html5.html **Software** 1. Microsoft Excel 2. EPA Suite, https://www.epa.gov/tsca-screening-tools/download-epi-suitetm-estimation-program-interface-v411

Academic course policy	The academic policy of the course is determined by the Academic Policy and the Policy of Academic Integrity of Al-Farabi Kazakh National University . Documents are available on the main page of IS Univer. **Integration of science and education.** The research work of students, undergraduates and doctoral students is a deepening of the educational process. It is organized directly at the departments, laboratories, scientific and design departments of the university, in student scientific and technical associations. Independent work of students at all levels of education is aimed at developing research skills and competencies based on obtaining new knowledge using modern research and information technologies. A research university teacher integrates the results of scientific activities into the topics of lectures and seminars (practical) classes, laboratory classes and into the tasks of the IWST, IWS, which are reflected in the syllabus and are responsible for the relevance of the topics of training sessions and assignments. **Attendance.** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course. Failure to meet deadlines results in loss of points. **Academic honesty.** Practical/laboratory classes, IWS develop the student's independence, critical thinking, and creativity. Plagiarism, forgery, the use of cheat sheets, cheating at all stages of completing tasks are unacceptable. Compliance with academic honesty during the period of theoretical training and at exams, in addition to the main policies, is regulated by the "Rules for the final control" , "Instructions for the final control of the autumn / spring semester of the current academic year" , "Regulations on checking students' text documents for borrowings". Documents are available on the main page of IS Univer. **Basic principles of inclusive education.** The educational environment of the university is conceived as a safe place where there is always support and equal attitude from the teacher to all students and students to each other, regardless of gender, race / ethnicity, religious beliefs, socio-economic status, physical health of the student, etc. All people need the support and friendship of peers and fellow students. For all students, progress is more about what they can do than what they can't. Diversity enhances all aspects of life. All students, especially those with disabilities, can receive counseling assistance by phone +77021072010 or e-mail bkenesov@gmail.com. **Integration MOOC (massive open online course).** In the case of integrating MOOC into the course, all students need to register for MOOC. The deadlines for passing MOOC modules must be strictly observed in accordance with the course study schedule. **ATTENTION!** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course, as well as in the MOOC. Failure to meet deadlines results in loss of points.

INFORMATION ABOUT TEACHING, LEARNING AND ASSESSMENT

Score-rating letter system of assessment of accounting for educational achievements

Grade	Digital equivalent points	points, % content	Assessment according to the traditional system
A	4.0 _	95-100	Great
A-	3.67	90-94	
B+	3.33	85-89	Fine
B	3.0	80-84	
B-	2.67	75-79	
C+	2.33	70-74	
C	2.0	65-69	Satisfactorily
C-	1.67	60-64	
D+	1.33	55-59	

Assessment Methods

Criteria-based assessment is the process of correlating actual learning outcomes with expected learning outcomes based on clearly defined criteria. Based on formative and summative assessment.

Formative assessment is a type of assessment that is carried out in the course of daily learning activities. It is the current measure of progress. Provides an operational relationship between the student and the teacher. It allows you to determine the capabilities of the student, identify difficulties, help achieve the best results, timely correct the educational process for the teacher. The performance of tasks, the activity of work in the classroom during lectures, seminars, practical exercises (discussions, quizzes, debates, round tables, laboratory work, etc.) are evaluated. Acquired knowledge and competencies are assessed.

Summative assessment - type of assessment, which is carried out upon completion of the study of the section in accordance with the program of the course. Conducted 3-4 times per semester when performing IWS. This is the assessment of mastering the expected learning outcomes in relation to the descriptors. Allows you to determine and fix the level of mastering the course for a certain period. Learning outcomes are evaluated.

Formative and summative assessment	Points % content
Seminars	9
Laboratory classes	22.5
Independent work	13.2
Assessments	15.3
Final control (exam)	40

D	1.0	50-54		TOTAL	100
FX	0,5	25-49	Unsatisfactory		
F	0	0-24			

Calendar (schedule) for the implementation of the content of the course. Methods of teaching and learning.

A week	Topic name	Number of hours	Max. points
	MODULE 1 Fundamental concepts of analytical chemistry.		
1	**L 1.** Basics of analytical chemistry. Analytical process and signals	1	-
	S 1. Application, importance and development of analytical chemistry	1	2
	LC 1. Determination of analyte concentration by density. Learning basic analytical laboratory glassware and equipment	4	5
2	**L 2.** Errors and uncertainties in chemical analysis	1	-
	S 2. Preparation of solutions of chemicals with a desired concentration and uncertainty	1	2
	LC 2. Preparation of samples with desired concentrations of chemicals and uncertainties	4	5
	IWS 1. Work on the solution of tasks 1	4	-
	IWST 1. Consultation on the solution of tasks	1	-
3	**L 3.** Homogeneous equilibria in analytical chemistry	1	-
	S 3. Calculation of equilibrium concentrations of different forms of analytes in aqueous solutions at different pH	1	2
	LC 3. Identification of inorganic cations	4	5
	IWS 1. Further work on the solution of tasks 1	4	-
	IWST 2. Consultation on the solution of tasks	1	-
4	**L 4.** Heterogeneous equilibria in analytical chemistry	1	-
	S 4. Calculation of equilibrium concentrations of analytes in different phases	1	2
	LC 4 Identification of inorganic anions	4	5
	A 1. Assessment 1	1	15
	IWS 1. Submission of solutions of tasks 1 on: – calculation of pH of solutions of acids and bases; – calculation of concentrations of molecular and ionic forms of acids and bases in their solutions at different pH; – calculation of equilibrium concentrations of an analyte in organic and water phases after liquid-liquid extraction; – converting between different concentration units; – preparing gaseous, liquid and solid samples with a desired concentration of an analyte and its uncertainty.	4	12
	MODULE 2 Chemical methods of analysis		
5	**L 5.** Gravimetric methods of analysis	1	-
	S 5. Problems and optimization of gravimetric analysis	1	2
	LC 5 Gravimetric determination of iron. Part 1: precipitation and filtration	4	5
	IWS 2. Work on the solution of tasks 2	4	-
6	**L 6.** Titrimetric analysis. Acid-base titration	1	-
	S 6. Building titration curves	1	2
	LC 6 Gravimetric determination of iron. Part 2: drying, measurement of mass, calculations and reporting	4	5
	IWST 3. Consultations on the solution of tasks 2	1	-
	IWS 2. Work on the solution of tasks 2	4	-
7	**L 7.** Titrimetry based on reactions of complexation and precipitation	1	-
	S 7. Redox titrations	1	2
	LC 7 Determination of water hardness	4	5
	A 2. Assessment 2	1	12
	IWS 2. Submission of solutions of tasks 2 on: – calculation of an analyte concentration from results of a gravimetric analysis; – calculation of an analyte concentration from results of a titrimetric analysis; – obtaining titration curves.	4	12
Midterm control 1			**100**
	MODULE 3 Electrochemical and spectroscopic methods of analysis		
8	**L 8.** Molecular spectroscopy	1	-
	S 8. Application and limitations of molecular spectroscopy	1	2
	LC 8 Photocolorimetric determination of iron in water. Calibration and analysis	4	5

	IWST 4. Consultations on the solution of tasks 3	1	-
	IWS 3. Work on the solution of tasks 3	4	-
9	**L 9.** Atomic spectroscopy	1	-
	S 9. Application and limitations of atomic spectroscopy	1	2
	LC 9 Photocolorimetric determination of iron in water. Data analysis and reporting	4	5
	IWS 3. Work on the solution of tasks 3	4	-
10	**L 10.** Theoretical background of electrochemical methods of analysis	1	-
	S 10. Potentiometric methods of analysis	1	2
	LC 10. Calibration of pH meter and pH measurements	4	5
	IWST 5. Consultations on the solution of tasks 3	1	-
	IWS 3. Work on the solution of tasks 3	4	-
11	**L 11.** Amperometric and voltammetric methods of analysis	1	-
	S 11. Chemical sensors	1	2
	LC 11. Potentiometric titration	4	5
	A 3. Assessment 3	1	12
	IWS 3. Submission of solutions of tasks 3 on: – obtaining calibration plots for spectroscopic methods; – calculation of an analyte concentration using results of spectroscopic measurements; – basics of electrochemical methods of analysis; – calibration of electrochemical methods; – calculation of an analyte concentration using results of electrochemical measurements.	4	10
MODULE 4 Chromatography, sample preparation and technique selection			
12	**L 12.** Gas chromatography	1	-
	S 12. Quantitation of organic compounds using gas chromatography	1	2
	LC 12. Determination of benzene in gasoline using gas chromatography	4	5
	IWS 4. Work on the solution of tasks 4	4	-
13	**L 13.** Liquid chromatography	1	-
	S 13. Quantitation of organic compounds using liquid chromatography	1	2
	LC 13. Determination of inorganic ions using ion chromatography	4	5
	IWST 6. Consultations on the solution of tasks 4	1	-
	IWS 4. Work on the solution of tasks 4	4	-
14	**L 14.** Sampling and sample preparation	1	-
	S 14. Optimization of sample preparation	1	2
	LC 14. Determination of benzene and toluene in air using gas chromatography and solid-phase microextraction	4	5
	IWST 7. Consultations on the solution of tasks 4	1	-
	IWS 4. Work on the solution of tasks 4	4	-
15	**L 15.** Selection of an analytical technique	1	-
	S 15. Problem solving using analytical chemistry	1	2
	LC 14. Determination of benzene and toluene in air using gas chromatography and solid-phase microextraction	4	5
	A 4. Assessment 4	1	12
	IWS 4. Submission of solutions of tasks 4 on: – calibration of chromatographic methods; – calculation of an analyte concentration using results of chromatographic measurements with and without sample preparation; – selection of a suitable analytical method.	4	10
Midterm control 2			**100**
Final control (exam)			**100**
TOTAL for course			**100**

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