DESCRIPTION OF THE COURSE OF STUDY

Course code	**0531-2CHEM-C02_AI**	
Name of the course in	Polish	***Analiza Instrumerntalna***
	English	**Instrumental Analysis**

1. LOCATION OF THE COURSE OF STUDY WITHIN THE SYSTEM OF STUDIES

1.1. Field of study	**Chemistry**
1.2. Mode of study	**Full-time studies**
1.3. Level of study	**Second-cycle master's studies**
1.4. Profile of study*	**General academic**
1.5. Person/s preparing the course description	**Prof. UJK dr hab. Mieczysław Scendo**
1.6. Contact	**scendo@ujk.edu.pl**

2. GENERAL CHARACTERISTICS OF THE COURSE OF STUDY

2.1. Language of instruction	**English**
2.2. Prerequisites*	**Fundamentals of Analytical Chemistry and Instrumental Analysis**

3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

3.1. Form of classes		**Lecture – 30 hours, Seminar – 15 hours, Laboratory exercises – 45 hours**
3.2. Place of classes		**Classes in the teaching rooms of the UJK**
3.3. Form of assessment		**Written exam. Seminar, laboratory: pass with grade. Presentation of a paper. Oral answers and preparation of reports based on measurement results from all exercises.**
3.4. Teaching methods		**Verbal (lecture and conversation), practical (laboratory exercises)**
3.5. Bibliography	**Required reading**	1.Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, New York, 2005. 2.Galen W. Ewing, Instrumental Methods of Chemical Analysis, New York 1980. 3.F. Scholz, Electroanalytical Methods, New York, 2010. Arl h. Hamann, Andrew Hamnett, Electrochemistry, Wiley-VCh, 2007. 4.A.M. Bond, Broadening Electrochemical Horizons, New York, 2002.
	Further reading	1.S. Glasstone, An Introduction to Electrochemistry, New York, 1991. 2.H. Lawrence, Van Vlack, Elements of Materials Science, London, 1994. 3.A.G. Whittaker, A.R. Mount, M.R. Heal, Instant Notes in Physical Chemistry, London, 2000. 4.R. Holze, Experimental Electrochemistry, Softcover, 2007.

1. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

4.1. Course objectives:

C 1. To familiarize students with the most frequently used instrumental methods used in chemical analysis (lecture).
C 2. Teaching students to make independent presentations based on appropriately selected literature using appropriate computer programs (classroom).
C 3. Preparing students to independently perform qualitative and quantitative analyses of substances using appropriate equipment and to correctly develop and interpret measurement results (laboratory).

4.2. Detailed syllabus ***(including form of classes)***

1. Lecture:

Electrochemical measurement equipment: Concepts and types of measurement equipment. General characteristics and division of methods. Operational amplifiers. The use of some operational amplifiers in the construction of measuring equipment. **Basic electrochemical methods:** Division of methods. Theoretical basics. AC sinusoidal and rectangular current polarography. The essence of current measurement in rectangular alternating current polarography. Normal and differential pulse polarography. Qualitative analysis and quantitative analysis methods. Equipment for AC and pulse measurements. Modern drop mercury electrodes. Modern polarographic vessels and sets of polarographic equipment.

Amperometry and amperometric titration: Division of methods. Types of electrodes, rotating disk electrode. Quantitative analysis. Amperometric titration with one or two polarized electrodes. Titration with electrodes polarized with constant current. Types of amperometric titration curves. Application of methods. **Coulometry and coulometric titration:** Electrolysis process. Faraday's laws. Methods of measuring electric charge. Integrators. Potentiostatic coulometry. Amperostatic coulometry. Preparation of titrant. Titration end point detection methods. Application of coulometry. **Atomic absorption spectrometry:** Radiated absorption by free atoms. Absorption environments. Excitation sources. Radiation release and its detection. Apparatus for atomic absorption spectrometry. Qualitative and quantitative analysis. Selection of patterns. Disturbing influences and their elimination. Spectral interferences and methods of their correction. Application of atomic absorption spectrometry. **Extraction:** Theoretical basis of the method. Overview of separation methods. Partition isotherm. Extraction in the solid phase - liquid phase system. Extraction in a two-liquid phase system. Extractive and spectrophotometric determination of elements. Extraction kits. Application of extraction. **X-ray spectroscopy:** X-ray radiation and its properties. X-ray sources. Radiation absorption. Characteristic radiation. Radiation intensity. X-ray photoelectron spectrometry. Auger effect. Auger electron spectrum. X-ray fluorescence method. X-ray fluorescence spectrometry spectrum. Identification of the substance. Quantifications. Apparatus. Application of methods.
2. Lab:
Students perform six laboratory exercises that are thematically related to the content of the lectures. Students must complete theoretical material related to the topic of the exercise based on the issues and relevant literature that are listed in the instructions for individual exercises. The method of carrying out the measurements and processing the results is described in detail in the instructions for a given exercise. The topics of the exercises and the order in which they are performed for individual teams are provided in the class schedule.
3. Seminar:
Students become familiar with the principles of operation of basic electronic systems that are used to build measurement sets. Students will prepare papers whose topics will complement the lecture content. The following issues will be discussed, among others: Selection of the analytical method. Preparing samples for analysis. Decomposition and dissolution of samples. Ion-solvent interactions. Thermodynamic properties of electrolyte solutions. Characteristics and properties of the electrochemical double layer. Characteristics of electrode processes. Ion transport in solutions. Kinetic methods and separation methods. Separation methods. Practical notes on chemical analysis. Interaction of radiation with matter. Radiation absorption. Basic concepts in statistical analysis. Measurement errors in chemical analysis. Statistical tests. Linear Regression.

4.3 Intended learning outcomes

Code	A student, who passed the course	Relation to learning outcomes
within the scope of **KNOWLEDGE:**		
W01	The student has extended knowledge of methods using electromagnetic radiation or chromatographic, thermal and voltammetric techniques.	CHEM2A-W04
within the scope of **ABILITIES:**		
U01	The student is able to use instrumental analytical techniques and is able to interpret spectra, chromatographic spectra, thermograms and voltammograms obtained using various research techniques.	CHEM2A-U01
U02	Based on spectra, chromatograms, thermograms and voltammograms, the student is able to perform a qualitative analysis and determine the mass of the tested substance.	CHEM2A-U01
within the scope of **SOCIAL COMPETENCE:**		
K01	The student understands the importance of knowledge in solving cognitive and practical problems.	CHEM2A-K01

4.4. Methods of assessment of the intended learning outcomes

Teaching outcomes *(code)*	Method of assessment (+/-)														
	Exam oral /written*			Test*			Project*			Group work*			Others* e.g. standardized test used in e-learning		
	Form of classes			*Form of classes*			*Form of classes*			*Form of classes*			*Form of classes*		
	L	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*	*L*	*C*	*...*
W01	+												+		
U01				+						+			+		
U02				+						+					
K01	+			+									+		

4.5. Criteria of assessment of the intended learning outcomes		
Form of classes	**Grade**	**Criterion of assessment**
Lecture (L) * (including e-learning)	**3**	the student obtained 60 - 69% correct answers
	3,5	the student obtained 70 - 79% correct answers
	4	the student obtained 80 - 89% correct answers
	4,5	the student obtained 90 - 94% correct answers
	5	the student obtained 95 - 100% correct answers
Classes (C) * (including e-learning)	**3**	the student obtained 60 – 69% on the presented paper
	3,5	the student obtained 70 - 79% on the presented paper
	4	the student obtained 80 – 89% on the presented paper
	4,5	the student obtained 90 – 94% on the presented paper
	5	the student obtained 95 - 100% on the presented paper
Other (…) * (including e-learning)	**3**	the student obtained 60 - 69% correct answers to the tests, completed all exercises and submitted all reports
	3,5	the student obtained 70 - 79% correct answers to the tests, completed all exercises and submitted all reports
	4	the student obtained 80 - 89% correct answers to the tests, completed all exercises and submitted all reports
	4,5	the student obtained 90 - 94% correct answers to the tests, completed all exercises and submitted all reports
	5	the student obtained 95 - 100% correct answers to the tests, completed all exercises and submitted all reports

4. BALANCE OF ECTS CREDITS – STUDENT'S WORK INPUT

Category	**Student's workload**	
	Full-time studies	
NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER /CONTACT HOURS/	***90***	
*Participation in lectures**	***30***	
*Participation in classes, seminars, laboratories**	***50***	
*Preparation in the exam/final test**	***10***	
INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/	***85***	
*Preparation for the lecture**	***30***	
*Preparation for the classes, seminars, laboratories**	***20***	
*Preparation for the exam/test**	***15***	
*Gathering materials for the project/Internet query**	***4***	
Preparation of multimedia presentation	***15***	
TOTAL NUMBER OF HOURS	***175***	
ECTS credits for the course of study	***7***	

Accepted for execution *(date and legible signatures of the teachers running the course in the given academic year)*

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