

SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	“Babes-Bolyai” University
1.2 Faculty	Chemistry and Chemical Engineering
1.3 Department	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Master
1.6 Study programme / Qualification	Advanced Chemical Process Engineering / Master’s degree in Chemical Engineering

2. Information regarding the discipline

2.1 Name of the discipline		Electrochemical sensors and biosensors - CME6232					
2.2 Course coordinator		Vacant position / Assoc. prof. habil. dr. eng. Graziella Liana TURDEAN					
2.3 Seminar coordinator		Vacant position / Assoc. prof. habil. dr. eng. Graziella Liana TURDEAN					
2.4. Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Type of discipline	Optional

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					56
Additional documentation (in libraries, on electronic platforms, field documentation)					26
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					3
Evaluations					3
Other activities: not the case					-
3.7 Total individual study hours	108				
3.8 Total hours per semester	150				
3.9 Number of ECTS credits	6				

4. Prerequisites (if necessary)

4.1. curriculum	<ul style="list-style-type: none"> Not the case
4.2. competencies	<ul style="list-style-type: none"> Not the case

5. Conditions (if necessary)

5.1. for the course	<ul style="list-style-type: none"> The students will turn off their mobile phones Delays will not be tolerated
5.2. for the seminar /lab activities	<ul style="list-style-type: none"> Students will attend the seminar with information of the course notes corresponding to the current seminar/lab topic Students will turn off their mobile phones Delays will not be tolerated

6. Specific competencies acquired

Professional competencies	<ul style="list-style-type: none"> • Doing physico-chemical experiments with higher difficulty degree and interpretation of results. • Identification, characterization and comparison of different instrumental techniques applicable in chemical and biochemical determinations. • Conducting experiments in view to determine the physico-chemical properties of specific compounds, processing and interpretation of obtained data. • Using an integrated complex instrumental techniques and its adjustment to new soft-ware products in order to apply them in specific analysis. • Using appropriate uni- and multivariate analysis techniques in the evaluation of physico-chemical properties. • Applying innovative concepts, theories and advanced physico-chemical techniques to solve a specific research topic.
Transversal competencies	<ul style="list-style-type: none"> • Independent execution of complex professional duties and research projects using computer-aided techniques and comply with professional ethics and moral. • Planning, monitoring and assuming professional duties of underline group. Proving the coordination capabilities, analytical thinking, adaptability and flexibility, collaboration with team members. • Self-assessment of professional performances and establish the needs of continuous learning, documentation in the work fields in correlation with the labour market.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	<ul style="list-style-type: none"> • The course provides theoretical and practical information about the devices and equipment necessary into applications in the bio/medical electroanalytical chemistry field • Obtaining theoretical knowledge about methods and stages of realization, the characterization of different types of electrochemical sensors and interpretation from analytical/kinetically point of view of the obtained responses. • Correlation of fundamental notions of analytical chemistry, kinetics, electrochemistry, biology, physiology, biochemistry, technology, and marketing applied in the bio/medical field.
7.2 Specific objective of the discipline	<ul style="list-style-type: none"> • Habituate the students with the newest information about electroanalytical methods for monitoring analytes in the bio/medical field using electrochemical sensors and biosensors. • Presentation of the construction, operating principle and working conditions or features of potentiometric, amperometric, conductimetric bio/sensors, underlying the determination methods of some important analytes. • Highlighting the latest analytical performance of each class of bio/sensors when used for analytical detection of species.

8. Content

8.1 Course	Teaching methods	Remarks
8.1.1. Introduction related to the history of the development of electrochemical sensors. Definitions. Classifications. General characteristics of the sensors (electrode function).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 1-6, p. 6-22]; [3, p. 11-16, p. 206-222].
8.1.2. General characteristics of the sensors (selectivity, influence of the temperature). The methodology of using sensors (methods of addition).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [3, p. 11-16, p. 206-222].
8.1.3. Potentiometric sensors based on solid membrane. Glass electrode.	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 22-29]; [3, p. 189-196].

8.1.4. Potentiometric sensors based on solid membrane (ion-selective electrodes, "all-solid-state" <i>versus</i> "membrane" version, potentiometric sensors based monocrystal membrane, LaF ₂)	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 22-29]; [3, p. 189-196].
8.1.5. Potentiometric sensors based on solid membrane. Membrane of silver sulphide and halides silver (Ag ₂ S-AgX), membranes of silver sulphide and metal sulphides (Ag ₂ S-MeS)).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 22-29]; [3, p. 189-196].
8.1.6. Potentiometric sensor based on liquid membrane.	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 30-52]; [3, p. 197-202].
8.1.7. Potentiometric gas sensors. Ion-selective electrode based on field effect transistors (FET).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 30-52]; [3, p. 197-202].
8.1.8. Amperometric sensors (Clark electrode, investigation techniques of amperometric electrode).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [2, p. 30-52]; [3, p. 197-202].
8.1.9. Enzyme-based electrochemical biosensors (biological receptor, immobilization techniques, enzyme heterogeneous kinetics (K _M , I _{max} , linearization), generation of biosensors).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1, p. 15-50, 54-89]; [2, p. 53-86]; [3, p. 45-111].
8.1.10. Glucose oxidase-based amperometric biosensors for the detection of glucose	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1, p. 15-50, 54-89]; [2, p. 53-86].
8.1.11 Enzyme based amperometric/potentiometric sensors for heavy metals detection,	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1].
8.1.12 Enzyme-based amperometric sensors for detection of lactate, cholesterol, creatinine, etc.	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1].
8.1.13. Enzyme based amperometric biosensors for detection analytes having antioxidant properties (phenols/phenol derivatives, hydrogen peroxide).	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1].
8.1.14. Amperometric biosensors for detection of pesticides based on the inhibition of acetylcholinesterase /butyrylcholinesterase.	Presentation; Explanation, Conversation; Description; Debate	<i>References:</i> [1]

References

1. Turdean G. L., Sarmiza S.E., Popescu I. C., **Biosenzori amperometrici**. Teorie si aplicatii, Presa Universitara Clujeana, Cluj-Napoca, **2005**.
2. Popescu I. C., **Senzori electrochimici**, Litografia UBB, **1996**.
3. Kékedy L., **Senzori electrochimici metalici si ioni**, Ed. Academiei, Bucuresti, **1987**.

Supplementary references

4. Fraden Jacob (ed), **Handbook of modern sensors. Physics, designs, and applications**, Springer, **2004**
5. Edmonds T. E., **Chemical Sensors**, Blakie and Son, Glasgow, **1988**.
6. Janata J., **Principles of Chemical Sensors**, Plenum Press, N.Y., **1989**.
7. Cass A.E.G., **Biosensors. A practical approach**, IRL Press, **1990**.
8. Hall A. H., **Biosensors**, Open Univ. Press, Buckingham, **1990**.
9. Blum L., Coulet P., **Biosensors. Principles and applications**, Marcel Dekker, New York, **1991**.
10. Bard A. J., **Integrated chemical systems. A Chemical approach to nanotechnology**, Wiley VCH, **1994**.
11. Fraser D. M., **Biosensors in the body. Continuous in vivo monitoring**, Willey VCH, **1997**.
12. Gardner J. W., Bartlett P. N., **Electronic noses. Principles and applications**, Oxford University

Press, 1999.		
13. Yui N., Supramolecular design for biological applications , CRC Press, 2002.		
8.2 Seminar	Teaching methods	Remarks
8.2.1. Instructions for working safety in laboratory. Do a graphics: statistical errors. Hazardous reagents, use of electroanalytical equipment.	Explanation; Conversation; Description; Debate	(2 h) <i>References:</i> Law “ <i>Ordinul nr. 339/16.08.1996</i> ”.
8.2.2.-8.2.3. Determination of selectivity coefficient of an ion-selective electrode. Applying of standard addition method.	Explanation; Conversation; Description; Debate	(4 h) <i>Key-words:</i> ion-selective electrode, selectivity coefficient, semilogarithmic calibration curve, interpolation, standard addition method, semi-antilog Gran's plot.
8.2.4. Amperometric sensor for oxygen detection: calibration, response time.	Explanation; Conversation; Description; Debate	(2 h) <i>Key-words:</i> chronoamperometry, analytical parameters (limit of detection, time of response).
8.2.5. Characterization of a glass sensor. Buffer capacity of a weakly acid.	Explanation; Conversation; Description; Debate	(2 h) <i>Key-words:</i> chronoamperometry, linearisations, kinetic parameters (Michaelis-Menten constant, I _{max})
8.2.6-8.2.7. Seminar: exercises and problems	Explanation; Conversation; Description; Debate; Problem solving	(4h)
References		
1. Popescu I.C., Turdean G.L., Nicoara A., Ilea P., Muresan L., Lucrari practice pentru ciclul de studii aprofundate in “Electrochimie aplicata” , lito UBB, Cluj-Napoca, 1997.		
2. Oniciu L., Popescu I.C., Ilea P., Muresan L., Rus E.M., Gyenge E., Madaras M., Nicoara A., Muresan C., Lucrari practice de Electrochimie si tehnologii electrochimice , lito UBB, Cluj-Napoca, 1993.		
3. Skoog D.A., West D. M., Holler F.J., Crouch S. R., Fundamentals of analytical chemistry , Thomson Brooks/Cole, 2004.		

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- By instructing the theoretical and practical concepts of **Electrochemical sensors and biosensors** course, the students will get the knowledge in accordance with the competencies requested by possible employment sectors stotted by “Grila 2 – RNCIS”.

10. Evaluation

Type of activity	10.1. Evaluation criteria	10.2. Evaluation methods	10.3. Share in the grade (%)
10.4. Course	Correctness of answers – proper understanding and learning of concepts discussed during lectures; Correct use of learned concept within new contexts.	Written exam. Access to the exam is subject to presentation of reports with interpretation of results obtained during laboratory experiments.	80%
	Correct solving of problems as inherent part of examination subjects.	Proven or intended fraud is punished according to the ECST rules of UBB.	
10.5. Seminar/ laboratory activities	Correctness answers, assimilation and understanding of the of concepts discussed during seminars The quality of prepared reports The work undertaken in the laboratory	The reports with interpretation of results obtained during laboratory experiments are taught at latest next week from the laboratory session.	20%

10.6. Minimum performance standards
<ul style="list-style-type: none">➤ Minimum Grade 5 (five) at the written exam, and minimum grade 6 at practical activities (laboratory + seminar).➤ Knowledge of the concepts used; description of the operating principle of a bio/sensor; solving problem for application / explaining of a real situation.

Date

Signature of course coordinator

Signature of seminar coordinator

31 martie 2017

Date of approval

Signature of the head of department
